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12th ANNUAL SYSTEMS ENGINEERING CONFERENCE

"Achieving Acquisition Excellence Via Effective Systems Engineering"

San Diego, CA

26 - 29 October 2009

Agenda

Tuesday, October 27, 2009

PLENARY SESSION 1 - INTRODUCTION & OPENING REMARKS
- Mr. Bob Rassa, Director, Systems Supportability, Raytheon; Chair, Systems Engineering Division, NDIA

KEYNOTE ADDRESS
- Honorable Zachary J. Lemnios, Director, Defense Research and Engineering, Office of the Secretary of Defense (Acquisition, Technology and Logistics)

PLENARY SESSION 2 - SERVICE ACQUISITION EXECUTIVES
VIEW FROM THE TOP: HOW CAN SE SUPPORT PROGRAM EXECUTION?
Moderator: Mr. Terry Jaggers, Principal Deputy, Systems Engineering, Office of the Director, Defense Research and Engineering
- Mr. David G. Ahern, Director, Portfolio Systems Acquisition, Office of the Secretary of Defense (Acquisition, Technology and Logistics)
- Mr. Thomas E. Mullins, Deputy Assistant Secretary for Plans, Programs and Resources (SAAL-ZR), Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology)
- Mr. Christopher A. Miller, PEO for Command, Control, Communications, Computers and Intelligence (C4I), ASNRDA
- Mr. Randall G. Walden, Director, Information Dominance Programs, Office of the Assistant Secretary of the Air Force (Acquisition), AFRCO

LUNCH WITH SPEAKER IN THE REGATTA PAVILION
- Mr. Stephen Welby, Director, Systems Engineering, Office of the Director, Defense Research and Engineering

PLENARY SESSION 3 - TEST & EVALUATION EXECUTIVES
VIEW FROM THE TOP: HOW SE CAN SUPPORT DEVELOPMENTAL TEST AND EVALUATION?
Moderator: Mr. Jim O'Bryon, The O'Bryon Group; Chair, Test and Evaluation Division
- Dr. James N. Streilein, Technical Advisor, HQ Army Test & Evaluation Command
- Ms. Amy Markowich, Deputy DoN T&E Executive
- Colonel Dexter M. Sapinoso, USAF, Chief of Air Force Test and Evaluation Policy and Programs
- Mr. Christopher DiPetto, OUSD(AT&L)/DDR&E/DT&E

PLENARY SESSION 4 - ***SE AND ACQUISITIONS REFORM: THE WAY AHEAD***
Moderator: Mrs. Kristen Baldwin, Office of the Director, Defense Research and Engineering
- Mr. Ross Guckert, Office of the Secretary of the Army for Acquisition, Logistics and Technology (ASA(ALT))
- Mr. Carl Siel, Office of the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN(RDA)CHSENG)
- Colonel Shawn Shanley, USAF, Chief Systems Engineer, Office of the Assistant Secretary of the Air Force for Acquisition, Science, Technology, and Engineering (SAF/AQR)
- Mr. Nicholas Torelli, Office of the Director, Defense Research and Engineering

WEDNESDAY, OCTOBER 28, CONCURRENT SESSIONS

TRACK 1
Systems Engineering Effectiveness - Bayview III

- 8851 - *Rapid Development and Integration of Remote Weapon Systems to Meet Operational Requirements*, Mr. Joseph Burkart, NSWC Crane, Small Arms Air Platform Integration
- 8893 - *Rapid Development,* Mr. Michael Gaydar, NAVAIR
- 8847 - *Tailoring the SE Process to Effectively Complement the SW Agile Development Process*, Mr. William Lyders, ASSETT Inc.
- 8902 - *Systems Engineering Leading Indicators: Insight into Effective Systems Engineering*, Mr. Gary Roedler, Lockheed Martin Corporation
- 9414 - *Correcting Deficiencies in the Systems Engineering of Tactical Weapons*, Mr. Marvin Ebbert, Raytheon Missile Systems
- 8948 - *Value Engineering Applications in Service Contracts*, Dr. Jay Mandelbaum, Value Engineering Applications in Service Contracts
- 8816 - *Mind the GAPs-a Systems Engineering Implementation of DoDI 5000.02*, Dr. Thomas Christian, U. S. Air Force
- 8990 - *Systems Engineering for Rapid Capability Development*, Mr. Thomas McDermott, Georgia Tech Research Institute
- 8974 - *Transforming Systems and Software Engineering Across an Enterprise*, Mr. Jeffery Wilcox, Lockheed Martin Corporation
- 8863 - *Using Requirements Compliance to Identify Gaps Between the Technical Solution and Requirements*, Mr. Frank Salvatore, High Performance Technologies, Inc.
- 8823 - *Win and Influence Design Engineers---Change Their Affordability DNA*, Mr. Tim Morrill, Raytheon Company

TRACK 2
Early System Engineering - Bayview II

- 8951 - *USAF View of NRC "Pre-A Systems Engineering" Study Committee Recommendations As Addressed By Levin-McCain (P.L. 111-23; "Weapon Systems Acquisition Reform Act of 2009"*), Mr. Jeff Loren, SAF/AQR (Alion Science & Technology)
- 8846 - *Air Force Materiel Command Early Systems Engineering*, Dr. Brian Kowal, USAF
- 9016 - *A Framework for Enhancing Forward-looking Capability Delivery Metrics*, Mr. Leonard Sadauskas, DoD CIO CT&S
- 9082 - *Including Environment, Safety, and Occupational Health (ESOH) Requirements in Joint Capabilities Integration and Development System (JCIDS) Documents*, Mr. Sherman Forbes, U.S. Air Force
- 8835 - *T&E Collaboration and Contributions during Early Program Acquisition*, Mr. Stephen Scukanec, Northrop Grumman Corporation Aerospace Systems
- 8795 - *Mission-based Test and Evaluation Strategy: Creating Linkages between Technology Development and Mission Capability*, Mr. John Beilfuss, U.S. Army Research Laboratory
- Panel Topic: 8924, 8925 , 8933 - *Early Systems Engineering in DoDI 5000.02*, Dr. Judith Dahmann, Ms. Lisa Reuss, Ms. Sharon Vannucci, Systems Engineering Directorate, ODDR&E
- 8949 - *Updated DoD 5000 and CJCS 3170 Policies: A Requirements to Acquisition Gap Analysis*, Mr. John Lohse, Raytheon Company
- 8813 - *Emerging Roles for Systems Engineering in Defense Decision Making; Better Aligning Requirements and Acquisition with the Budget and Security Environments*, Mr. Vincent Roske, Institute for Defense Analyses
- 9026 - *Early SE Determination of Best-Fit System Life Cycle Processes*, Dr. Barry Boehm, USC

TRACK 3 - Technology Maturity - Bayview I

- 8991 - *Systems Engineering for the Science & Technology Community*, Mr. Russell Menko, U. S. Army RDECOM/TARDEC
- 9017 - *Linking Systems Engineering Artifacts with Complex Systems Maturity Assessments*, Dr. Brian Sauser, Stevens Institute of Technology
- 8770 - *Incorporating Maturity Assessment into House of Quality for Improved Decision Support Analysis and Risk Management*, Mr. Pavel Fomin, U.S. Air Force
- 8798 - *The New Technology Readiness Assessment Process*, Dr. Jay Mandelbaum, Institute for Defense Analyses
- 8870 - *S&T Portfolio Maturity & Performance Analysis: The Concept of Critical Research Elements*, Mr. Has Patel, Infologic, Inc.
- 8879 - *TRL Vectors in IPPD-based Portfolio Management*, Mr. Michael Bartmess, General Dynamics/AIS
- 8963 - *Air Force Concept Maturity Assessment*, Mr. George Freeman, U.S. Air Force, Center for Systems Engineering
- 8900 - *DOD's Weapon System Portfolio: Are Results Getting Any Better?*, Mr. Michael Sullivan, U.S. Government
- 8894 - *Air Force Initiative – High Confidence Technology Transition Planning Through the Use of Stage-Gates – Update*, Mr. Randy Bullard, U.S. Air Force Materiel Command
- 8891 - *A comprehensive overview of techniques for measuring system readiness*, Mr. James Bilbro, JB Consulting International

TRACK 4 - Test and Evaluation of SOS - Mission I

- 8825 - *Test and Evaluation in a System of Systems Environment*, Mr. Edwin McDermott, 653 ELSW, Electronic Systems Center
- 8849 - *Joint Integration and Interoperability Lab (JSIIL)*, Mr. Steven Whitehead, SL, J8 Technical Director, USJFCOM
- 8935 - *Systems of Systems Systems Engineering and Test and Evaluation*, Dr. Judith Dahmann, Systems Engineering Directorate, ODDR&E/MITRE

TRACK 4 - Practical Systems Engineering - Mission I

- 9014 - *SAVI: Aerospace Platform Development and Certification Using Modeling and Simulation to "Integrate, then Build"*, Mr. Gregory Pollari, Rockwell Collins
- 8855 - *Certify and Fly Right: Preparing for DO-297 Certification*, Mr. Ketih Custer, Esterline Control Systems-AVISTA
- 8973 - *C-17 Transition to Criteria-based Airworthiness Certification*, Mr. Christian Stillings, USAF 516 AESG

TRACK 4 - Test and Evaluation - Mission I

- 8848 - *Integrated Testing: We Can Do It*, Dr. Beth Wilson, Raytheon Company
- 8882 - *Test & Evaluation Strategy for the Technology Development Phase*, Ms. Darlene Mosser-Kerner, OUSD(AT&L)/DDR&E/DT&E
- 8883 - *Test & Evaluation Products for the Systems Engineering Reviews*, Mr. Woody Eischens, OUSD(AT&L)/DDR&E/DT&E
- 8814 - *Joint Mission Environment Test Capability (JMETC), Lowering technical Risk by Improving Distributed Test Capabilities*, Mr. Chip Ferguson, JMETC
- 8901 - *Review Results of the NDIA/OSD Software Test Summit/Workshop*, Mr. Thomas Wissink, Lockheed Martin IS&GS

TRACK 5 - Human Systems Integration - Mission II

- 8998 - *Human Systems Integration – Ensuring the Human is Considered "Left of A"*, Col Larry Kimm, USAF, U.S Air Force
- 8885 - *Human Systems Integration (HSI) - Integrating Human Concerns into Life Cycle Systems Engineering*, Ms. Cynthia Shewell, Booz Allen

Hamilton

- 9012 - *Human Systems Integration: Defining and Validating a Framework for Enhanced Systems Development,* Dr. Matthew Risser, Pacific Science & Engineering Group
- 8975 - *What is Human Systems Integration (HSI) and why should we do it?,* Mr. Stuart Booth, Systems Engineering Directorate, ODDR&E
- 9042 - *Bounding the Human Within the System*, Mr. Michael Mueller, U.S. Air Force Center for Systems Engineering
- 8829 - *The Army Health Hazard Assessment Program's Medical Cost Avoidance Model,* Dr. Timothy A. Kluchinsky, Department of Army

TRACK 5 - System Safety - ESOH - Mission II

- 9095 - *Using Proposed MIL-STD-882 Change 1 For Hazardous Materials Management,* Ms. Karen Gill, Booz Allen Hamilton
- 8890 - *Building Safer UGVs with Run-time Safety Invariants,* Mr. Michael Wagner, Carnegie Mellon University, NREC
- Sherman Forbes, U.S. Air Force
- 882D - *Overview of Draft MIL-STD-882D With Change 1*, Mr. Bob Smith, Booz Allen Hamilton
- 9070 - *Improving Safety Technology Insertion in DoD Acquisition Programs,* Dr. Elizabeth Rodriguez-Johnson, Systems Engineering Directorate, ODDR&E
- 9094 - *DoD Green Procurement Program Update and Path Forward,* Mr. David Asiello, Office of the Secretary of Defense
- 9091 - *Environment, Safety, and Occupational Health (ESOH) Risk and Technology Requirements Reporting at Acquisition Program Reviews,* Ms. Lucy Rodriguez, Booz Allen Hamilton

TRACK 6 - System of Systems - Mission III

- 8898 - *Designing Collaborative Systems of Systems in support of Multi-sided Markets*, Mr. Philip Boxer, SEI
- 8892 - *SysML Strategies to Characterize and Analyze Systems of Systems*, Dr. Jo Ann Lane, University of Southern California
- 9041 - *On Modeling and Simulation Methods for Capturing Emergent Behaviors for Systems of Systems*, Dr. Jack Zentner, Georgia Tech Research Institute
- 9060 - *M&S Support for SoS SE,* Dr.Joann Lane, USC
- 8776 - *The Modular SOS Paradigm: an Availability Paradox?*, Mr. Peter Gentile, Northrop Grumman Corporation
- 8866 - *Extending FMECA to Systems of Systems,* Mr. Leopoldo Mayoral, Johns Hopkins University/APL
- *NDIA SoS Committee Report*, Dr. Judith Dahman, Systems Engineering Directorate, ODDR&E/MITRE
- 8960 - *A Distillation of Lessons Learned from Complex System of Systems Acquisitions*, Dr. Richard Turner, Stevens Institute
- 8784 - *Establishing a Departmental-Level Systems-of-Systems Engineering Management Construct for the Department of the Navy, Progress Report*, Mr. John Kevin Smith, Asst Sec of the Navy for RD&A, Chief Engineer
- 8942 - DoD Systems of Systems Update, Dr. Judith Dahmann, Systems Engineering Directorate, ODDR&E/MITRE
- 8961 - Engineering Systems of Systems: An Integration Perspective, Dr. Emmett Maddry, NSWCDD

TRACK 7 - Program Management - Palm I

- 8979 - *Boots on the Ground: Tactical Planning at Program Start Up,* Mr. Gerry Becker, Harris Corporation
- 8999 - *Program Signature Measurement*, Mr. James Thompson, Systems Engineering Directorate, ODDR&E
- 9103 - *The Economics of CMMI,* Mr. Geoff Draper, Harris Corporation
- 8995 - *Integrated Systems Engineering and Developmental Test and Evaluation,* Mr. Chris DiPetto, DUSD(A&T)/SSE
- 9021 - *Critical Success Factors for Milestone Review Risk Identification,* Dr. Barry Boehm, USC
- 9030 - *Lessons Learned in Motivating Software Engineering Process Group to Focus on Achieving Business Goals and Not on Just Achieving a Maturity Level*, Mr. Girish Seshagiri, Advanced Information Services Inc.
- 9003 - CMMI® for Executives, Mr. Geoff Draper, Harris Corporation
- 9034 - Sustainment and Continued Institutionalization of Best Practices and CMMI® at SPAWAR, Mr. Michael Kutch, SPAWAR Systems Center Atlantic
- 8791 - Cost and Risk Impacts of the New DOD 5000 Defense Acquisition Framework, Dr. Peter Hantos, The Aerospace Corporation
- 8895 - A Comprehensive Review of Maturity Assessment Approaches for Improved Defense Acquisition, Ms. Nazanin Azizian, The George Washington University

TRACK 8 - Net-Centric Operations/Interoperability - Palm II

- 8874 - *The Boeing System of Systems Engineering (SoSE) Process and Its Use in Developing Legacy-Based Net-Centric Systems of Systems*, Mr. John Palmer, The Boeing Company
- 9010 - *Network Enabled Weapons, A System Engineering Approach to Achieve Interoperabilty*, *Mr. Andrew Lieux*, Naval Air Warfare Center Weapons Division
- 8854 - *Human Interoperability Enterprise and Net Centric Operations,* Mr. Jack Zavin, ASD (NII)
- 8780 - *Net-Centric Best Practices,* Mr. Hiekeun Ko, JPEO-CBD - Software Support Activity
- 8788 - *Data sharing in a Stability Operations Community of Interest: Utilizing a pilot program to prove concepts and develop trust.*, Mr. Gerald Christman, Femme Comp Inc.
- 8853 - *C4I Architecture for Joint ASW*, Mr. Gregory Miller, Naval Postgraduate School
- 8929 - *Extending Net-Centric Quality of Service to Systems of Systems*, Maj Vinod Naga, USAF, Air Force Institute of Technology
- 9081 - *Testing in Service-oriented Environments*, Mr. Soumya Simanta, SEI
- 8913 - *Linking Interoperability and Measures of Effectiveness: A Method for Evaluating Architectures*, Dr. David Jacques, Air Force Institute of Technology

TRACK 8 - Speciality Engineering - Palm II

- 8944 - *DoD's Refocus on Specialty Engineering (Reliability, Availability and Maintainability; Producibility and Quality, Supportability, Safety and Human Systems Integration)*, Mr. Chester Bracuto, Systems Engineering Directorate, ODDR&E
- 9043 - *Implementing the Materiel Availability KPP in DoD acquisition programs—balancing life-cycle costs with warfighter needs,* Mr. Grant Schmieder, Systems Engineering Directorate, ODDR&E
- 8873 - *IUID enables streamlined acquisition and system engineering,* Mr. Robert Leibrandt, DoD UID Policy Office
- 8958 - *Security Systems Engineering,* Mrs. Kristen Baldwin, Systems Engineering Directorate, ODDR&E

THURSDAY, OCTOBER 29, CONCURRENT SESSIONS

TRACK 1 - Systems Engineering Effectiveness - Bayview III

- 8887 - *Achieving a Systems Engineering Culture in a Science and Technology Laboratory Environment,* Mr. Robert Rapson, Materials and Manufacturing Directorate, AFRL
- 8920 - *A Methodology for Assessing Systems Engineering Practices,* Ms. Lauren Levy, Johns Hopkins University/APL
- 9097 - *Acquisition ESOH Risk Management-How to Make It Work,* Mr. Bob Smith, Booz Allen Hamilton

TRACK 1 - Architecture - Bayview III

- 8831 - *Human-Centered Design in Systems Engineering: Human View Methodology,* Dr. Robert Smillie, SPAWAR
- 8830 - *Systems Engineering Needs of the DoDAF – Report of the Architecture Frameworks Working Group,* Mr. Joe Kuncel, Northrop Grumman Corporation
- 8824 - *Delivering DoDAF Version 2.0 to Architects and Systems Engineers for IT Systems and Services*, Mr. Walt Okon, Department of Defense, CIO, Enterprise Architecture
- 8971 - *Advancing Systems Engineering Practice using Model Based System Development,* Mr. Sanford Friedenthal, Lockheed Martin Corporation
- 9004 - *Evolving Systems Engineering through Model Driven Functional Analysis,* Dr. Mark Blackburn, Systems and

TRACK 2 - Logistics Systems - Bayview II

- 9063 - *An Integrated RAM Approach to System Design and Support,* Mr. Robert Finlayson, Johns Hopkins University/APL
- 9031 - *Supportability Lessons Learned with Line Replaceable Modules,* Ms. Heity Hsiung, Raytheon Company
- 8908 - *Successful First AESA Deployment through Application of System Engineering,* Mr. Scott Nichols, Raytheon Company
- 9039 - *Applying Systems Engineering to Fielded Weapon Systems and End-Items,* Mr. Michael Ucchino, AF Center for Systems Engineering
- 9008 - *Upgrade Fluid System Filter Element Monitoring To Increase Operational Reliability and Support Condition Based Maintenance Capability,* Mr. Gary Rosenberg, Constellation Technology Corportation
- 8834 - *Tailoring Systems Engineering for Technical Support of Legacy Products,* Mr. Joseph Skandera, BAE Systems
- 9092 - *The role of simulation in tracking mobile assets using RFID technology,* Mr. Swee Leong, National Institute of Standards and Technology

TRACK 3 - Modeling & Simulation - Bayview I

- 8939 - *Understanding the New DoD Instruction 5000.61: "DoD Modeling & Simulation Verification, Validation and Accreditation (VV&A)",* Mr. Michael Truelove, Systems Engineering Directorate, ODDR&E
- 8950 - *Live, Virtual, Constructive Architecture Roadmap: The Quest for Interoperability, Standards, and Reuse,* Dr. Gary Allen, Joint Training Integration & Evaluation Center
- 9048 - *Revisions to the Acquisition Modeling & Simulation Master Plan,* Mr. Stephen Swenson, Systems Engineering Directorate, ODDR&E
- 8759 - *A Systems Engineering Framework for Integrating M&S Development Best Practices,* Dr. Katherine Morse, Johns Hopkins University/APL
- 9052 - Best Practices in Contracting for Models, Simulations, and Associated Data, Mr. Dennis Shea, CNA
- 8947 - *Report on a Study on Management Concepts for Broadly-Needed Modeling and Simulation Tools in the U.S. Department of Defense,* Dr. James Coolahan, Johns Hopkins University/APL
- 8836 - *Producibility Modeling & Simulation Needs for Early Systems Engineering Evaluations of Alternative Design Concepts,* Dr. Al Sanders, Honeywell Aerospace
- 8810 - *Using Simulation to Define and allocate probabilistic Requirements,* Ms. Yvonne Bijan, Lockheed Martin Aeronautics
- 8923 - *Integration of Operational Simulations With Physics-Based Models For Engineering Analysis,* Mr. Stephen Guest, Lockheed Martin Aeronautics

TRACK 4 - Practical Systems Engineering - Mission I

- 8980 - *Using Model-driven Engineering Techniques for Integrated Flight Simulation Development,* Mr. Douglas Fiehler, Raytheon Missile Systems
- 9007 - *Technology Maturation for the Automated Aerial Refueling (AAR) Project*, Ms. Carol Ventresca, SynGenics Corporation
- 8880 - *Naval Postgraduate School Advanced Seabase Enabler Project: A Systems Engineering Case Study,* Mr. Lance Flitter, NSWC, Carderock Division
- 8946 - *Protecting the Mission, Preserving Legacy and Promoting Growth,* Ms. Patti Scaramuzzo, Lockheed Martin Corporation
- 9054 - *A-10 Avionics System Architecture Trade Study and Analysis (AVSATA) Program,* Mr. Richard Sorensen, KIHO Military Acquisition Consulting, Inc.
- 8976 - *A Systems Engineering Model for Roadmap Alignment,* Mr. Si Dok, U. S. Army TARDEC
- 9080 - *Rapid Systems Engineering of the MRAP Gunner Restraint System Saves Lives*, Ms. Michelle Bowen, JPO MRAP
- 9002 - *Key Considerations for Building Highly Available, Mission-Critical Systems,* Mr. Stephen Mills, GoAhead Software

TRACK 5 - Human Systems Integration - Mission II

- 8937 - *Integrating the Human into the system, integrating HSI Tools into Systems Engineering*, Dr. Jennifer Narkevicius, Jenius LLC
- 9064 - *Economics of Human Systems Integration: Early Life Cycle Cost Estimation Using HSI Requirements*, 2ndLt Kevin Liu, USMC, MIT
- *Proccess Management and tool selection to minimize risk of hand-arm vibration syndrome*, Mr. Sherman Forbes, U.S. Air Force

TRACK 5 - Systems Engineering Development Environment - Mission II

- 8945 - *Standards Based Development Environment,* Mr. Christopher Oster, Lockheed Martin Corporation
- 8922 - *The Role of DoD in Systems Engineering Standards and Models,* Mr. Donald Gantzer, Systems Engineering Directorate, ODDR&E
- 8844 - *The Power of the Spec: Understanding the Many Diverse Roles in SE of Good Specifications & Standards.",* Mr. Robert Kuhnen, U.S. Air Force

- 8967 - *Generating Visual and Interactive Output from System Engineering Tools*, Mr. John Schatz, Systems and Proposal Engineering Company
- 9015 - *Challenges and Benefits of applying ISO STEP*, Mr. Stuart Booth, Systems Engineering Directorate, ODDR&E
- 9059 - *Smallsat Conceptual Design Trade and Cost Modeling Tool*, Dr. Deganit Armon, Advatech Pacific, Inc

TRACK 6 - Enterprise Health Management - Mission III

- 8815 - *Applying Systems Engineering to Operational System Improvements*, Ms. Ryanne Gentry, Acquisition Logistics Engineering
- 8842 - *Applications in Integrated Diagnostics*, Mr. Jimmy Simmons, Georgia Tech Research Institute
- 8884 - *Tactical Wheeled Vehicle Integrated Diagnostics*, Mr Lawrence Osentoski, DRIVE Developments, Inc.

TRACK 6 - System of Systems - Mission III

- 8964 - *Software Assurance in a System of Systems World: Interoperability Challenges - Reports from the Field*, Dr. Carol Sledge, SEI
- 8969 - *An Introduction to Influence Maps: Foundations, Construction, and Use*, Mr. James Smith, SEI
- 9024 - *Dynamic Modeling of Programmatic and Systematic*, Dr. Brian Sauser, Purdue University
- 8915 - *System of Systems Challenges and Solutions: Case Study Insights*, Mr. John Colombi, U.S. Air Force Institute of Technology

TRACK 7 - Work Force Development - Palm I

- 8966 - *Improving Systems Engineering Curriculum Using a Competency-Based Assessment Approach*, Ms. Alice Squires, Stevens Institute of Technology
- 9088 - *Enhancing Systems Engineering Competencies in the Enterprise*, Mr. Gary Roedler, Lockheed Martin Corporation
- 8789 - *Achieving Acquisition Excellence via Improving the Systems-Engineering Workforce*, Dr. Kenneth Nidiffer, SEI
- 8926 - *Systems Engineering Workforce Development Update*, Dr. Don Gelosh, Systems Engineering Directorate, ODDR&E
- 9076 - *Assessing Systems Engineering Personnel Competency: Framework and Tool Experience*, Dr. Barry Boehm, University of Southern California
- 8943 - *Team SE Skill Set*, Mr. Charles Garland, U.S. Air Force Center for Systems Engineering
- 8956 - *Systems Engineering Approach to Workforce Development*, Mr. James Miller, U.S. Air Force
- 9046 - *Developing an Introductory Systems Engineering Practitioners Course: "Model-Based Systems Engineering (MBSE) With SysML"*, Mr. Joseph Wolfrom, Johns Hopkins University/APL
- 8878 - *Advanced Simulation Course for Army Simulation Management Professionals*, Dr. Gene Paulo, Naval Postgraduate School

TRACK 8 - Software Intensive Systems - Palm II

- 8977 - *Overview of DoD Software Engineering Initiatives*, Mr. Scott Lucero, Systems Engineering Directorate, ODDR&E
- 8820 - *Graduate Software Engineering Reference Curriculum (GSwERC)*, Ms. Nicole Hutchison, Analytic Services, Inc.
- 8739 - *Quality Assessment of Software-Intensive System Architectures and their Requirements (QUASAR*), Mr. Donald Firesmith, SEI
- 8812 - *A Systems Engineering Approach to Multi-Level Security in a Service Oriented Architecture*, Mr. Timothy Greer, Lockheed Martin Corporation
- 9104 - *Static Code Analysis: Best Practices for Software Assurance in the Acquisition Life Cycle*, Mr. Paul Croll, CSC
- 8996 - *Engineering Improvement in Software Assurance: A Landscape Framework*, Ms. Lisa Brownsword, SEI
- 8802 - *Open Source Technology for Enterprise Health Management*, Mr. Edward Beck, CSC
- 8901 - *Review Results of the NDIA/OSD Software Test Summit/Workshop*, Mr. Thomas Wissink, Lockheed Martin IS&GS
- 9506 - *Software Acquisition Management Practical Experience*, Mr. James Jones, SSAI

▸ CONFERENCE OVERVIEW

The NDIA Systems Engineering conference is focused on improving acquisition and performance of Defense programs and systems, including net-centric operations and data/information interoperability, system-of-systems engineering and all aspects of system sustainment. Convened in San Diego, CA, October 26-29, 2009, this conference is sponsored by the National Defense Industrial Association, Systems Engineering Division, with technical co-sponsorship by IEEE AES, IEEE Systems Council and the International Council on Systems Engineering, and is supported by the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, Office of the Director, Defense Research & Engineering/Systems Engineering.

▸ BACKGROUND

The Department of Defense continues to work to improve the acquisition of military equipment and capability to assist the warfighter in protecting the U.S. and its allies, and help oppressed nations around the world, amidst continuously changing conditions and threats. The DoD seeks to improve the acquisition process and overall program execution of military systems, to provide greater, more effective and reliable warfighting capability, at affordable cost and within reasonable schedules. One of the primary and critically important areas of program acquisition and execution lies in the umbrella discipline of Systems Engineering, which is the overall integrating function in defense programs, from proper requirements definition & flowdown, effective and affordable design that integrates reliability, availability and maintainability considerations into the overall balance of design that emphasizes supportability and usage aspects along with overall performance, cost and schedule. Systems Engineering principles embody strong technical and risk management aspects, for both the acquiring program office as well as the executing defense prime and subcontractors. Strong emphasis on Systems Engineering throughout the life cycle of the program, from concept development through sustainment, is a key enabler of successful programs. The annual Systems Engineering Conference explores the role of Systems Engineering in defense programs from all aspects and perspectives, including the pragmatic, practical and academic viewpoints, and brings key practitioners together to work on effective solutions to achieving a successful warfighting force.

▸ CONFERENCE OBJECTIVES

This conference seeks to create an interactive forum for Program Managers, Systems Engineers, Chief Scientists and Engineers and Managers from the Requirements, Design, Verification, Support, Logistics and Test communities from Government, Academia, and Industry. The conference will provide the opportunity to shape policy and procedures by exchanging innovative tactics and lessons learned.

▸ CONTACTS

Technical Program Co-Chairs:
Mr. Steve Henry,
Manager, Systems Engineering and Program Support, Northrop Grumman Information Systems, stephen.henry@ngc.com, (703) 561-5724

Dr. Tom Christian,
ASC/EN, thomas.christian@wpafb.af.mil, (478) 926-2457

Conference Chair:
Mr. Bob Rassa,
Director, Systems Supportability, Raytheon; Chair, Systems Engineering Division, NDIA, rcrassa@raytheon.com, (310) 985-4962

Meeting Planner:
Ms. Suzanne Havelis,
NDIA, shavelis@ndia.org, (703) 247-2570.

Conference Director:
Mr. Sam Campagna,
NDIA, scampagna@ndia.org, (703) 247-2544

▸ ATTIRE

Appropriate dress for this conference is business casual for civilians and class B uniform for military. During conference registration and check-in, each participant will be issued an identification badge. Please be prepared to present a picture ID. Badges must be worn at all conference functions.

▸ CONFERENCE PROCEEDINGS

Proceedings will be available on the web through the Defense Technical Information Center (DTIC), and will be available one to two weeks after the conference. You will receive notification via e-mail once proceedings are posted and available on the web.

▸ CONTINUING EDUCATION UNIT CREDIT

NDIA is offering CEU credit options for the Systems Engineering Conference. For more information, please contact Ms. Suzanne Havelis at 703.247.2570 or shavelis@ndia.org.

▸ 2010 CALL FOR PAPERS INFORMATION

The primary objective of the 13th Annual Systems Engineering Conference is to provide insight, information and lessons learned into how we can improve the overall performance of defense programs via a better, more focused application of systems engineering that will lead to more capable, interoperable and supportable weapon systems for the warfighter, with reduced total ownership costs, to help our military meet its current and new mission area and capabilities requirements. Technical and management presentations are a key tactic in achieving this objective. You are invited to submit a short (under 300 word) abstract of a presentation for a session (see topics on the website). Abstracts must fully describe the planned content and how the presentations will advance the objectives of the conference and session. All accepted presentations will be delivered at the conference in electronic format; full papers are optional and are not required.

Abstracts must include the following administrative information: presentation title, author's name, title, e-mail address, phone number, mailing address and organization and the conference session targeted. Abstracts must be submitted no later than Sunday, May 30, 2010 via the following web link:

http://application.ndia.org/abstracts/1870

Abstracts will only be accepted through this web link, and all required information must be completed. Upon completion of the required information, you will receive an e-mail confirmation.

**Conference presenters are not exempt from registration and conference fees.

CONFERENCE AGENDA

SUNDAY, OCTOBER 25, 2009

5:00 pm - 7:00 pm	**REGISTRATION FOR TUTORIALS AND GENERAL CONFERENCE**

MONDAY, OCTOBER 26, 2009

7:00 am - 6:00 pm	**REGISTRATION**
7:00 am - 8:00 am	**CONTINENTAL BREAKFAST (FOR TUTORIAL ATTENDEES ONLY)**
8:00 am - 12:00 pm	**TUTORIAL TRACKS**
9:45 am - 10:15 am	**MORNING BREAK (FOR TUTORIAL ATTENDEES ONLY)**
12:00 pm - 1:00 pm	**LUNCH (FOR TUTORIAL ATTENDEES ONLY)**
1:00 pm - 5:00 pm	**TUTORIAL TRACKS CONTINUED**
2:45 pm - 3:15 pm	**AFTERNOON BREAK (FOR TUTORIAL ATTENDEES ONLY)**
5:00 pm - 6:00 pm	**RECEPTION IN THE REGATTA PAVILION - OPEN TO ALL CONFERENCE ATTENDEES**

TUESDAY, OCTOBER 27, 2009

7:15 am - 7:00 pm **REGISTRATION**

7:15 am - 8:15 am **CONTINENTAL BREAKFAST IN THE REGATTA PAVILION**

8:15 am - 8:30 am **PLENARY SESSION 1 - INTRODUCTION & OPENING REMARKS**

- Mr. Sam Campagna, *Director, Operations, NDIA*
- Mr. Bob Rassa, *Director, Systems Supportability, Raytheon*; *Chair, Systems Engineering Division, NDIA*

8:30 am - 9:30 am **KEYNOTE**

- Honorable Zachary J. Lemnios, *Director, Defense Research and Engineering, Office of the Under Secretary of Defense (Acquisition, Technology and Logistics)*

9:30 am - 10:00 am **MORNING BREAK IN THE REGATTA PAVILION**

10:00 am - 12:00 pm **PLENARY SESSION 2 - ACQUISITION EXECUTIVES PANEL**

View from the Top: How Can SE Support Program Execution?

Moderator: Mr. Terry Jaggers, *Principal Deputy, Systems Engineering, Office of the Director, Defense Research and Engineering*

- Mr. David G. Ahern, *Director, Portfolio Systems Acquisition, Office of the Under Secretary of Defense (Acquisition, Technology and Logistics)*
- Mr. Thomas E. Mullins, *Deputy Assistant Secretary for Plans, Programs, and Resources (SAAL-ZR), Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology)*
- Mr. Christopher A. Miller, *PEO for Command, Control, Communications, Computers and Intelligence (C4I), U.S. Navy*
- Mr. Randall G. Walden, *Director, Information Dominance Programs, Office of the Assistant Secretary of the Air Force (Acquisition)*

12:00 pm - 1:30 pm **LUNCH WITH SPEAKER IN THE REGATTA PAVILION**

- Mr. Stephen Welby, *Director, Systems Engineering, Office of the Director, Defense Research and Engineering*

TUESDAY, OCTOBER 27, 2009 - CONTINUED

1:30 pm - 3:15 pm

PLENARY SESSION 3 - TEST & EVALUATION EXECUTIVES PANEL
View from the Top: How SE Can Support Test and Evaluation?
Moderator: Mr. Jim O'Bryon, *The O'Bryon Group; Chair, NDIA Test and Evaluation Division*
- Dr. James N. Streilein, *Technical Advisor, HQ Army Test & Evaluation Command*
- Ms. Amy Markowich, *Deputy DoN T&E Executive*
- Colonel Dexter M. Sapinoso, USAF, *Chief of Air Force Test and Evaluation Policy and Programs*
- Mr. Christopher DiPetto, *Acting Director, DevelopmentalTest and Evaluation, Office of the Director, Defense Research and Engineering*

3:15 pm - 3:30 pm

AFTERNOON BREAK IN THE REGATTA PAVILION

3:30 pm - 5:15 pm

PLENARY SESSION 4 - SE AND ACQUISITION REFORM: THE WAY AHEAD
Moderator: Mrs. Kristen Baldwin, *Systems Engineering Directorate, Office of the Director, Defense Research and Engineering*
- Mr. Ross Guckert, *Office of the Secretary of the Army for Acquisition, Logistics and Technology (ASA(ALT))*
- Mr. Carl Siel, *Office of the Assistant Secretary of the Navy for Research, Development and Acquisition (ASN(RDA)CHSENG)*
- Colonel Shawn Shanley, USAF, *Chief Systems Engineer, Office of the Assistant Secretary of the Air Force for Acquisition, Science, Technology, and Engineering (SAF/AQR)*
- Mr. Nicholas Torelli, *Systems Engineering Directorate, Office of the Director, Defense Research and Engineering*

5:30 pm - 7:00 pm

RECEPTION IN THE REGATTA PAVILION

WEDNESDAY, OCTOBER 28, 2009

7:00 am - 5:15 pm	**REGISTRATION**
7:00 am - 8:00 am	**CONTINENTAL BREAKFAST IN THE REGATTA PAVILION**
8:00 am - 12:00 pm	**CONCURRENT SESSIONS -** *Please refer to the following pages for session schedule*
9:45 am - 10:15 am	**MORNING BREAK IN THE REGATTA PAVILION**
12:00 pm - 1:30 pm	**AWARDS LUNCH IN THE REGATTA PAVILION**
1:30 pm - 5:15 pm	**CONCURRENT SESSIONS -** *Please refer to the following pages for session schedule*
3:15 pm - 3:30 pm	**AFTERNOON BREAK IN THE REGATTA PAVILION**
5:15 pm	**WEDNESDAY SESSION ADJOURNS**

THURSDAY, OCTOBER 29, 2009

7:00 am - 3:00 pm	**REGISTRATION**
7:00 am - 8:00 am	**CONTINENTAL BREAKFAST IN THE REGATTA PAVILION**
8:00 am - 12:00 pm	**CONCURRENT SESSIONS -** *Please refer to the following pages for session schedule*
9:45 am - 10:15 am	**MORNING BREAK IN THE REGATTA PAVILION**
12:00 pm - 1:00 pm	**LUNCH IN THE REGATTA PAVILION**
1:00 pm - 3:00 pm	**CONCURRENT SESSIONS -** *Please refer to the following pages for session schedule*
3:00 pm	**CONFERENCE ADJOURNS**

MONDAY, OCTOBER 26, TUTORIAL SESSIONS

TRACK	8:00 AM SESSION A	10:15 AM SESSION B	1:00 PM SESSION C	3:15 PM SESSION D
TRACK 8 Palm II	8819 - 1A8 - Tutorial: Rethinking Risk Management Ms. Audrey Dorofee, SEI/CMU	8819 - 1B8 - Tutorial: Rethinking Risk Management Ms. Audrey Dorofee, SEI/CMU	8877 - 1C8 - Tutorial: Best Practices in Modeling and Simulation Dr. Gene Paulo, Naval Postgraduate School	8877 - 1D8 - Tutorial: Best Practices in Modeling and Simulation Dr. Gene Paulo, Naval Postgraduate School
TRACK 7 Palm I	8785 - 1A7 - Tutorial: Agile Development in Defense Acquisition Dr. Peter Hantos, The Aerospace Corporation	8785 - 1B7 - Tutorial: Agile Development in Defense Acquisition Dr. Peter Hantos, The Aerospace Corporation	8801 - 1C7 - Tutorial: Integrating SE with Earned Value Management Mr. Paul Soloman, Performance-Based Earned Value	8801 - 1C7 - Tutorial: Integrating SE with Earned Value Management Mr. Paul Soloman, Performance-Based Earned Value
TRACK 6 Mission III	9078 - 1A6 - Tutorial: Organizational Implications of SoS Ms. Suzanne Garcia, SEI/CMU	9078 - 1B6 - Tutorial: Organizational Implications of SoS Ms. Suzanne Garcia, SEI/CMU	8782 - 1C6 - Tutorial: Technology Transition and the Defense Acquisition System Mr. William Decker, DAU	8782 - 1C6 - Tutorial: Technology Transition and the Defense Acquisition System Mr. William Decker, DAU
TRACK 5 Mission II	8984 - 1A5 - Tutorial: How to use Lean SE Processes to Save Time and Money Mr. Tim Olson, Lean Solutions Institute, Inc.	8984 - 1B5 - Tutorial: How to use Lean SE Processes to Save Time and Money Mr. Tim Olson, Lean Solutions Institute, Inc.	9072 - 1C5 - Tutorial: Leveraging the Defense Acq Program Support (DAPS) Methodology to Conduct Program Assessment Mr. Peter Nolte, Systems Engineering Directorate, ODDR&E	9072 - 1D5 - Tutorial: Leveraging the Defense Acq Program Support (DAPS) Methodology to Conduct Program Assessment Mr. Peter Nolte, Systems Engineering Directorate, ODDR&E
TRACK 4 Mission I	9035 - 1A4 - Tutorial: Collaborative Decision Making Dr. Tommer Ender, Georgia Tech Research Institute	9035 - 1B4 - Tutorial: Collaborative Decision Making Dr. Tommer Ender, Georgia Tech Research Institute	8931 - 1C4 - Tutorial: Role of Mentoring in Developing the Sys Eng Workforce Mr. Nicholas Torelli, Systems Engineering Directorate, ODDR&E	8931 - 1D4 - Tutorial: Role of Mentoring in Developing the Sys Eng Workforce Mr. Nicholas Torelli, Systems Engineering Directorate, ODDR&E
TRACK 3 Bayview I	8955 - 1A3 -Tutorial: Early Sys Thinking and Planning in WPN Sys Concept Phase Mr. Jeff Loren, SAF/AQR (Alion Science & Technology)	8955 - 1B3 -Tutorial: Early Sys Thinking and Planning in WPN Sys Concept Phase Mr. Jeff Loren, SAF/AQR (Alion Science & Technology)	9040 - 1C3 - Tutorial: Implementing the Materiel Availability KPP in DoD Acquisition Programs Mr. Grant Schmieder, Systems Engineering Directorate, ODDR&E	9040 - 1D3 - Tutorial: Implementing the Materiel Availability KPP in DoD Acquisition Programs Mr. Grant Schmieder, Systems Engineering Directorate, ODDR&E
TRACK 2 Bayview II	8779 - 1A2 - Tutorial: Mission Based Test and Eval Strategy: Case Study Mr. Christopher Wilcox, U.S. Army Test and Evaluation Command	8779 - 1B2 - Tutorial: Mission Based Test and Eval Strategy: Case Study Mr. Christopher Wilcox, U.S. Army Test and Evaluation Command	8818 - 1C2 - Tutorial: Integrated Testing Enhances SE Dr. Beth Wilson, Raytheon Company	8818 - 1D2 - Tutorial: Integrated Testing Enhances SE Dr. Beth Wilson, Raytheon Company
TRACK 1 Bayview III	8736 -1A1 - Tutorial: Framework of Engineering Architectures Mr. Donald Firesmith, SEI	8736 - 1B1 - Tutorial: Framework of Engineering Architectures Mr. Donald Firesmith, SEI	8992 -1C1 -Tutorial: SoS Quality Attribute Specification and Architecture Evaluation Mr. Michael Gagliardi, SEI	8992 -1D1 -Tutorial: SoS Quality Attribute Specification and Architecture Evaluation Mr. Michael Gagliardi, SEI

WEDNESDAY, OCTOBER 28, CONCURRENT SESSIONS

TRACK	SESSION CHAIR	8:00 AM	8:35 AM	9:10 AM	TRACK	SESSION CHAIR	10:15 AM	10:50 AM	11:25 AM
TRACK 8 Net-Centric Operations/ Interoperability Palm II	**Mr. Jack Zavin**, *ASD (NII)*	8780 - Net-Centric Best Practices Mr. Hiekeun Ko, JPEO-CBD - Software Support Activity	8788 - Data sharing in a Stability Operations Community of Interest: Utilizing a pilot program to prove concepts and develop trust. Mr. Gerald Christman, Femme Comp Inc.	8853 - C4I Architecture for Joint ASW Mr. Gregory Miller, Naval Postgraduate School	TRACK 8 Net-Centric Operations/ Interoperability Palm II	**Mr. Jack Zavin**, *ASD (NII)*	8929 - Extending Net-Centric Quality of Service to Systems of Systems Maj Vinod Naga, USAF, Air Force Institute of Technology	9081 - Testing in Service-oriented Environments Mr. Soumya Simanta, SEI	8913 - Linking Interoperability and Measures of Effectiveness: A Method for Evaluating Architectures Dr. David Jacques, Air Force Institute of Technology
TRACK 7 Program Management Palm I	**Mr. Hal Wilson**, *Northrop Grumman Corporation* and **Ms. Dona Lee**, *Systems Engineering Directorate,*	9003 - CMMI® for Executives Mr. Geoff Draper, Harris Corporation	9034 - Sustainment and Continued Institutionalization of Best Practices and CMMI® at SPAWAR Mr. Michael Kutch, SPAWAR Systems Center Atlantic	9065 - Rapidly Implementing Lean CMMI® Processes That Meet Business Needs Mr. Tim Olson, Lean Solutions Institute, Inc	TRACK 7 Program Management Palm I	**Mr. Hal Wilson**, *Northrop Grumman Corporation* and **Ms. Dona Lee**, *Systems Engineering Directorate, ODDR&E*	8982 - Systemic Root Cause Analysis – Driving Improvements into the Acquisition Process Mr. Peter Nolte, Systems Engineering Directorate, ODDR&EE)	8791 - Cost and Risk Impacts of the New DOD 5000 Defense Acquisition Framework Dr. Peter Hantos, The Aerospace Corporation	8895 - A Comprehensive Review of Maturity Assessment Approaches for Improved Defense Acquisition Ms. Nazanin Azizian, The George Washington University
TRACK 6 System of Systems Mission III	**Dr. Judith Dahman**, *Systems Engineering Directorate, ODDR&E/ MITRE* and **Mr. John Palmer**, *Boeing*	NDIA SoS Committee Report Dr. Judith Dahman, Systems Engineering Directorate, ODDR&E/ MITRE	8960 - A Distillation of Lessons Learned from Complex System of Systems Acquisitions Dr. Richard Turner, Stevens Institute	8784 - Establishing a Departmental-Level Systems-of-Systems Engineering Management Construct for the Department of the Navy, Progress Report Mr. John Kevin Smith, Asst Sec of the Navy for RD&A, Chief Engineer	TRACK 6 System of Systems Mission III	**Dr. Judith Dahman**, *Systems Engineering Directorate, ODDR&E/ MITRE* and **Mr. John Palmer**, *Boeing*	8840 - Naval Systems of Systems Engineering Guidebook Update Ms. Melinda Reed, DoD (ASN RDA CHSENG)	8942 - DoD Systems of Systems Update Dr. Judith Dahmann, Systems Engineering Directorate, ODDR&E/ MITRE	8961 - Engineering Systems of Systems: An Integration Perspective Dr. Emmett Maddry, NSWCDD
TRACK 5 Human Systems Integration Mission II	**Mr. Stuart Booth**, *Systems Engineering Directorate, ODDR&E*	8975 - What is Human Systems Integration (HSI) and why should we do it? Mr. Stuart Booth, Systems Engineering Directorate, ODDR&E	9042 - Bounding the Human Within the System Mr. Michael Mueller, U.S. Air Force Center for Systems Engineering	8829 - The Army Health Hazard Assessment Program's Medical Cost Avoidance Model Dr. Timothy A. Kluchinsky, Department of Army	TRACK 5 System Safety - ESOH Mission II	**Mr. Sherman Forbes**, *U.S. Air Force*	9070 - Improving Safety Technology Insertion in DoD Acquisition Programs Dr. Elizabeth Rodriguez-Johnson, Systems Engineering Directorate, ODDR&E	9094 - DoD Green Procurement Program Update and Path Forward Mr. David Asiello, Office of the Secretary of Defense	9091 - Environment, Safety, and Occupational Health (ESOH) Risk and Technology Requirements Reporting at Acquisition Program Reviews Ms. Lucy Rodriguez, Booz Allen Hamilton

TRACK 4 Test and Evaluation Mission I	**Dr. Beth Wilson**, *Raytheon Company*	8848 - Integrated Testing: We Can Do It Dr. Beth Wilson, Raytheon Company	8882 - Test & Evaluation Strategy for the Technology Development Phase Ms. Darlene Mosser-Kerner, OUSD(AT&L)/DDR&E/DT&E	8883 - Test & Evaluation Products for the Systems Engineering Reviews Mr. Woody Eischens, OUSD(AT&L)/DDR&E/DT&E	TRACK 4 Test and Evaluation Mission I	**Dr. Beth Wilson**, *Raytheon Company*	8814 - Joint Mission Environment Test Capability (JMETC), Lowering technical Risk by Improving Distributed Test Capabilities Mr. Chip Ferguson, JMETC	8901 - Review Results of the NDIA/OSD Software Test Summit/Workshop Mr. Thomas Wissink, Lockheed Martin IS&GS	
TRACK 3 Technology Maturity Bayview I	**Mr. Bill Nolte**, *WPAFB* and **Mr. James Malas**, *U.S. Air Force Research Laboratory*	8916 - System Readiness - Assessing Technical Risk Throughout the Lifecycle Mr. James Thompson, Systems Engineering Directorate, ODDR&E	8963 - Air Force Concept Maturity Assessment Mr. George Freeman, U.S. Air Force, Center for Systems Engineering	8900 - DOD's Weapon System Portfolio: Are Results Getting Any Better? Mr. Michael Sullivan, U.S. Government Accountability Office	TRACK 3 Technology Maturity Bayview I	**Mr. Bill Nolte**, *WPAFB* and **Mr. James Malas**, *U.S. Air Force Research Laboratory*	8894 - Air Force Initiative – High Confidence Technology Transition Planning Through the Use of Stage-Gates – Update Mr. Randy Bullard, U.S. Air Force Materiel Command	8833 - Communicating Risk: Air Force RI3 Methodology Mr. John Cargill, AF Cost Analysis Agency	8891 - A comprehensive overview of techniques for measuring system readiness Mr. James Bilbro, JB Consulting International
TRACK 2 Early System Engineering Bayview II	**Mr. John Lohse**, *Raytheon Company* and **Mr. Jeff Loren**, *SAF/AQR (Alion Science & Technology)*	Panel Topic: 8924, 8925 , 8933 - Early Systems Engineering in DoDI 5000.02 Dr. Judith Dahmann, Ms. Lisa Reuss, Systems Engineering Directorate, ODDR&E		Q&A: 8924, 8925 , 8933 - Early Systems Engineering in DoDI 5000.02 Dr. Judith Dahmann, Ms. Lisa Reuss, Systems Engineering Directorate, ODDR&E	TRACK 2 Early System Engineering Bayview II	**Mr. John Lohse**, *Raytheon Company* and **Mr. Jeff Loren**, *SAF/AQR (Alion Science & Technology)*	8949 - Updated DoD 5000 and CJCS 3170 Policies: A Requirements to Acquisition Gap Analysis Mr. John Lohse, Raytheon Company	8813 - Emerging Roles for Systems Engineering in Defense Decision Making; Better Aligning Requirements and Acquisition with the Budget and Security Environments Mr. Vincent Roske, Institute for Defense Analyses	9026 - Early SE Determination of Best-Fit System Life Cycle Processes Dr. Barry Boehm, USC
TRACK 1 Systems Engineering Effectiveness Bayview III	**Mr. Al Brown**, *The Boeing Company*	8816 - Mind the GAPs-a Systems Engineering Implementation of DoDI 5000.02 Dr. Thomas Christian, U. S. Air Force	8990 - Systems Engineering for Rapid Capability Development Mr. Thomas McDermott, Georgia Tech Research Institute	8974 - Transforming Systems and Software Engineering Across an Enterprise Mr. Jeffery Wilcox, Lockheed Martin Corporation	TRACK 1 Systems Engineering Effectiveness Bayview III	**Mr. Al Brown**, *The Boeing Company*	8863 - Using Requirements Compliance to Identify Gaps Between the Technical Solution and Requirements Mr. Frank Salvatore, High Performance Technologies, Inc.	8823 - Win and Influence Design Engineers---Change Their Affordability DNA Mr. Tim Morrill, Raytheon Company	8839 - Navy Systems Engineering Technical Review Process Ms. Melinda Reed, DoD (ASN RDA CHSENG)

WEDNESDAY, OCTOBER 28, CONCURRENT SESSIONS

TRACK	SESSION CHAIR	1:30 PM	2:05 PM	2:40 PM	TRACK	SESSION CHAIR	3:30 PM	4:05PM	4:40 PM
TRACK 8 Net-Centric Operations/Interoperability Palm II	**Mr. Jack Zavin**, *ASD (NII)*	8874 - The Boeing System of Systems Engineering (SoSE) Process and Its Use in Developing Legacy-Based Net-Centric Systems of Systems Mr. John Palmer, The Boeing Company	9010 - Network Enabled Weapons, A System Engineering Approach to Achieve Interoperabilty Mr. Andrew Lieux, Naval Air Warfare Center Weapons Division	8854 - Human Interoperability Enterprise and Net Centric Operations **Mr. Jack Zavin**, *ASD (NII)*	TRACK 8 Speciality Engineering Palm II	**Mr. Joel Moorvitch**, *Raytheon Company*	8944 - DoD's Refocus on Specialty Engineering (Reliability, Availability and Maintainability; Producibility and Quality, Supportability, Safety and Human Systems Integration) Mr. Chester Bracuto, Systems Engineering Directorate, ODDR&E	9043 - Implementing the Materiel Availability KPP in DoD acquisition programs—balancing life-cycle costs with warfighter needs Mr. Grant Schmieder, Systems Engineering Directorate, ODDR&E	8873 - IUID enables streamlined acquisition and system engineering Mr. Robert Leibrandt, DoD UID Policy Office 8958 - Security Systems Engineering Mrs. Kristen Baldwin, Systems Engineering Directorate, ODDR&E
TRACK 7 Program Management Palm I	**Mr. Hal Wilson**, *Northrop Grumman Corporation* and ***Ms. Dona Lee**, Systems Engineering Directorate, ODDR&E*	8979 - Boots on the Ground: Tactical Planning at Program Start Up Mr. Gerry Becker, Harris Corporation	8999 - Acquisition Program Technical Measurement Mr. James Thompson, Systems Engineering Directorate, ODDR&E	9103 - The Economics of CMMI Mr. Geoff Draper, Harris Corporation	TRACK 7 Program Management Palm I	**Mr. Hal Wilson**, *Northrop Grumman Corporation* and **Ms. Dona Lee**, *Systems Engineering Directorate, ODDR&E*	8995 - Integrated Systems Engineering and Developmental Test and Evaluation Mr. Chris DiPetto, OUSD(AT&L)/ DDR&E/DT&E	9021 - Critical Success Factors for Milestone Review Risk Identification Dr. Barry Boehm, USC	9030 - Lessons Learned in Motivating Software Engineering Process Group to Focus on Achieving Business Goals and Not on Just Achieving a Maturity Level Mr. Girish Seshagiri, Advanced Information Services Inc.
TRACK 6 System of Systems Mission III	**Dr. Judith Dahman**, *Systems Engineering Directorate, ODDR&E/MITRE* and **Mr. John Palmer**, *Boeing*	8898 - Designing Collaborative Systems of Systems in support of Multi-sided Markets Mr. Philip Boxer, SEI	8892 - SysML Strategies to Characterize and Analyze Systems of Systems Dr. Jo Ann Lane, University of Southern California	9041 - On Modeling and Simulation Methods for Capturing Emergent Behaviors for Systems of Systems Dr. Jack Zentner, Georgia Tech Research Institute	TRACK 6 System of Systems Mission III	**Dr. Judith Dahman**, *Systems Engineering Directorate, ODDR&E/MITRE* and **Mr. John Palmer**, *Boeing*	9060 - M&S Support for SoS SE Dr.Joann Lane, USC	8776 - The Modular SOS Paradigm: an Availability Paradox? Mr. Peter Gentile, Northrop Grumman Corporation	8866 - Extending FMECA to Systems of Systems Mr. Leopoldo Mayoral, Johns Hopkins University/APL
TRACK 5 Human Systems Integration Mission II	**Mr. Stuart Booth**, *Systems Engineering Directorate, ODDR&E*	8998 - Human Systems Integration – Ensuring the Human is Considered "Left of A" Col Larry Kimm, USAF, U.S Air Force	8885 - Human Systems Integration (HSI) - Integrating Human Concerns into Life Cycle Systems Engineering Ms. Cynthia Shewell, Booz Allen Hamilton	9012 - Human Systems Integration: Defining and Validating a Framework for Enhanced Systems Development Dr. Matthew Risser, Pacific Science & Engineering Group	TRACK 5 System Safety - ESOH Mission II	**Mr. Sherman Forbes**, *U.S. Air Force*	9095 - Acquisition ESOH Risk Management and HAZMAT Management Part I: Hazardouse Materials Management Plan Ms. Lucy Rodriguez, Booz Allen Hamilton	8890 - Building Safer UGVs with Run-time Safety Invariants Mr. Michael Wagner, Carnegie Mellon University, NREC	882D - Overview of Draft MIL-STD-882D With Change 1 Mr. Bob Smith, Booz Allen Hamilton

TRACK 4 Test and Evaluation of SoS Mission I	**Dr. Beth Wilson,** *Raytheon Company*	8825 - Test and Evaluation in a System of Systems Environment Mr. Edwin McDermott, 653 ELSW, Electronic Systems Center	8849 - Joint Integration and Interoperability Lab (JSIIL) Mr. Steven Whitehead, SL, J8 Technical Director, USJFCOM	8935 - Systems of Systems Systems Engineering and Test and Evaluation Dr. Judith Dahmann, Systems Engineering Directorate, ODDR&E/ MITRE	TRACK 4 Practical Systems Engineering Mission I	**Mr. Dana Peterson,** *DRS Technologies, Inc.*	9014 - SAVI: Aerospace Platform Development and Certification Using Modeling and Simulation to "Integrate, then Build" Mr. Gregory Pollari, Rockwell Collins	8855 - Certify and Fly Right: Preparing for DO-297 Certification Mr. Ketih Custer, Esterline Control Systems-AVISTA	8973 - C-17 Transition to Criteria-based Airworthiness Certification Mr. Christian Stillings, USAF 516 AESG
TRACK 3 Technology Maturity Bayview I	**Mr. Bill Nolte,** *WPAFB* and **Mr. James Malas,** *U.S. Air Force Research Laboratory*	8991 - Systems Engineering for the Science & Technology Community Mr. Russell Menko, U. S. Army RDECOM/TARDEC	9017 - Linking Systems Engineering Artifacts with Complex Systems Maturity Assessments Dr. Brian Sauser, Stevens Institute of Technology	8770 - Incorporating Maturity Assessment into House of Quality for Improved Decision Support Analysis and Risk Management Mr. Pavel Fomin, U.S. Air Force	TRACK 3 Technology Maturity Bayview I	**Mr. Bill Nolte,** *WPAFB* and **Mr. James Malas,** *U.S. Air Force Research Laboratory*	8798 - The New Technology Readiness Assessment Process Dr. Jay Mandelbaum, Institute for Defense Analyses	8870 - S&T Portfolio Maturity & Performance Analysis: The Concept of Critical Research Elements Mr. Has Patel, Infologic, Inc.	8879 - TRL Vectors in IPPD-based Portfolio Management Mr. Michael Bartmess, General Dynamics/AIS
TRACK 2 Early System Engineering Bayview II	**Mr. John Lohse,** *Raytheon Company* and **Mr. Jeff Loren,** *SAF/AQR (Alion Science & Technology)*	8951 - USAF View of NRC "Pre-A Systems Engineering" Study Committee Recommendations As Addressed By Levin-McCain (P.L. 111-23; "Weapon Systems Acquisition Reform Act of 2009") Mr. Jeff Loren, SAF/AQR (Alion Science & Technology)	8846 - Air Force Materiel Command Early Systems Engineering Dr. Brian Kowal, USAF	9016 - A Framework for Enhancing Forward-looking Capability Delivery Metrics Mr. Leonard Sadauskas, DoD CIO CT&S	TRACK 2 Early System Engineering Bayview II	**Mr. John Lohse,** *Raytheon Company* and **Mr. Jeff Loren,** *SAF/AQR (Alion Science & Technology)*	9082 - Including Environment, Safety, and Occupational Health (ESOH) Requirements in Joint Capabilities Integration and Development System (JCIDS) Documents Mr. Sherman Forbes, U.S. Air Force	8835 - T&E Collaboration and Contributions during Early Program Acquisition Mr. Stephen Scukanec, Northrop Grumman Corporation Aerospace Systems	8795 - Mission-based Test and Evaluation Strategy: Creating Linkages between Technology Development and Mission Capability Mr. John Beilfuss, U.S. Army Research Laboratory
TRACK 1 Systems Engineering Effectiveness Bayview III	**Mr. Al Brown,** *The Boeing Company*	8851 - Rapid Development and Integration of Remote Weapon Systems to Meet Operational Requirements Mr. Joseph Burkart, NSWC Crane, Small Arms Air Platform Integration	8893 - Rapid Development Mr. Michael Gaydar, NAVAIR	8847 - Tailoring the SE Process to Effectively Complement the SW Agile Development Process Mr. William Lyders, ASSETT Inc.	TRACK 1 Systems Engineering Effectiveness Bayview III	**Mr. Al Brown,** *The Boeing Company*	8902 - Systems Engineering Leading Indicators: Insight into Effective Systems Engineering Mr. Gary Roedler, Lockheed Martin Corporation	9414 - Correcting Deficiencies in the Systems Engineering of Tactical Weapons Mr. Marvin Ebbert, Raytheon Missile Systems	8948 - Value Engineering Applications in Service Contracts Dr. Jay Mandelbaum, Value Engineering Applications in Service Contracts

THURSDAY, OCTOBER 29, CONCURRENT SESSIONS

TRACK	SESSION CHAIR	8:00 AM	8:35 AM	9:10 AM	TRACK	SESSION CHAIR	10:15 AM	10:50 AM	11:25 AM
TRACK 8 Software Intensive Systems Palm II	**Mr. Paul Croll,** *CSC* and **Mr. Scott Lucero,** *Systems Engineering Directorate, ODDR&E*	8977 - Overview of DoD Software Engineering Initiatives Mr. Scott Lucero, Systems Engineering Directorate, ODDR&E	8820 - Graduate Software Engineering Reference Curriculum (GSwERC) Ms. Nicole Hutchison, Analytic Services, Inc.	8739 - Quality Assessment of Software-Intensive System Architectures and their Requirements (QUASAR) Mr. Donald Firesmith, SEI	TRACK 8 Software Intensive Systems Palm II	**Mr. Paul Croll,** *CSC* and **Mr. Scott Lucero,** *Systems Engineering Directorate, ODDR&E*	8812 - A Systems Engineering Approach to Multi-Level Security in a Service Oriented Architecture Mr. Timothy Greer, Lockheed Martin Corporation	9104 - Static Code Analysis: Best Practices for Software Assurance in the Acquisition Life Cycle Mr. Paul Croll, CSC	8996 - Engineering Improvement in Software Assurance: A Landscape Framework Ms. Lisa Brownsword, SEI
TRACK 7 Work Force Development Palm I	**Dr. Don Gelosh,** *Systems Engineering Directorate, ODDR&E* and **Mr. Mike Ucchino,** *U.S. Air Force Center for Systems Engineering*	8926 - Systems Engineering Workforce Development Update Dr. Don Gelosh, Systems Engineering Directorate, ODDR&E	9076 - Assessing Systems Engineering Personnel Competency: Framework and Tool Experience Dr. Barry Boehm, University of Southern California	8943 - Team SE Skill Set Mr. Charles Garland, U.S. Air Force Center for Systems Engineering	TRACK 7 Work Force Development Palm I	**Dr. Don Gelosh,** *Systems Engineering Directorate, ODDR&E* and **Mr. Mike Ucchino,** *U.S. Air Force Center for Systems Engineering*	8966 - Improving Systems Engineering Curriculum Using a Competency-Based Assessment Approach Ms. Alice Squires, Stevens Institute of Technology	9088 - Enhancing Systems Engineering Competencies in the Enterprise Mr. Gary Roedler, Lockheed Martin Corporation	8789 - Achieving Acquisition Excellence via Improving the Systems-Engineering Workforce Dr. Kenneth Nidiffer, SEI
TRACK 6 System of Systems Mission III	**Dr. Judith Dahman,** *Systems Engineering Directorate, ODDR&E/MITRE* and **Mr. John Palmer,** *Boeing*	9083 - Requirements Engineering for Systems of Systems Mr. Soumya Simanta, SEI	8964 - Software Assurance in a System of Systems World: Interoperability Challenges - Reports from the Field Dr. Carol Sledge, SEI	8969 - An Introduction to Influence Maps: Foundations, Construction, and Use Mr. James Smith, SEI	TRACK 6 System of Systems Mission III	**Dr. Judith Dahman,** *Systems Engineering Directorate, ODDR&E/MITRE* and **Mr. John Palmer,** *Boeing*	9024 - Dynamic Modeling of Programmatic and Systematic Dr. Brian Sauser, Purdue University	8903 - Global Earth Observation System of Systems (GEOSS) Mr. Lawrence McGovern, Northrop Grumman Electronic Systems	8915 - System of Systems Challenges and Solutions: Case Study Insights Mr. John Colombi, U.S. Air Force Institute of Technology
TRACK 5 Human Systems Integration Mission II	**Mr. Stuart Booth,** *Systems Engineering Directorate, ODDR&E*	8937 - Integrating the Human into the system, integrating HSI Tools into Systems Engineering Dr. Jennifer Narkevicius, Jenius LLC	9064 - Economics of Human Systems Integration: Early Life Cycle Cost Estimation Using HSI Requirements 2ndLt Kevin Liu, USMC, MIT	Process management and tool selection to minimize risk of hand-arm vibration syndrome Mr. Sherman Forbes, U.S. Air Force	TRACK 5 Systems Engineering Development Environment Mission II	**Mr. Al Brown,** *The Boeing Company*	8945 - Standards Based Development Environment Mr. Christopher Oster, Lockheed Martin Corporation	8922 - The Role of DoD in Systems Engineering Standards and Models Mr. Donald Gantzer, Systems Engineering Directorate, ODDR&E	8844 - The Power of the Spec: Understanding the Many Diverse Roles in SE of Good Specifications & Standards." Mr. Robert Kuhnen, U.S. Air Force

TRACK 4 Practical Systems Engineering Mission I	**Mr. Dana Peterson**, *DRS Technologies, Inc.*	8875 - Tomahawk Weapon System Development and Integration Mr. Gustavo Rivera, Naval Surface Warfare Center, Dahglren Division	8980 - Using Model-driven Engineering Techniques for Integrated Flight Simulation Development Mr. Douglas Fiehler, Raytheon Missile Systems	9007 - Technology Maturation for the Automated Aerial Refueling (AAR) Project Ms. Carol Ventresca, SynGenics Corporation	TRACK 4 Practical Systems Engineering Mission I	**Mr. Dana Peterson**, *DRS Technologies, Inc.*	8880 - Naval Postgraduate School Advanced Seabase Enabler Project: A Systems Engineering Case Study Mr. Lance Flitter, NSWC, Carderock Division	8946 - Protecting the Mission, Preserving Legacy and Promoting Growth Ms. Patti Scaramuzzo, Lockheed Martin Corporation	9054 - A-10 Avionics System Architecture Trade Study and Analysis (AVSATA) Program Mr. Richard Sorensen, KIHO Military Acquisition Consulting, Inc.
TRACK 3 Modeling & Simulation Bayview I	**Mr. Jim Coolahan, JHU/APL**	8939 - Understanding the New DoD Instruction 5000.61: "DoD Modeling & Simulation Verification, Validation and Accreditation (VV&A)" Mr. Michael Truelove, Systems Engineering Directorate, ODDR&E	8950 - Live, Virtual, Constructive Architecture Roadmap: The Quest for Interoperability, Standards, and Reuse Dr. Gary Allen, Joint Training Integration & Evaluation Center	9048 - Revisions to the Acquisition Modeling & Simulation Master Plan Mr. Stephen Swenson, Systems Engineering Directorate, ODDR&E	TRACK 3 Modeling & Simulation Bayview I	**Mr. Jim Coolahan, JHU/APL**	8759 - A Systems Engineering Framework for Integrating M&S Development Best Practices Dr. Katherine Morse, Johns Hopkins University/APL	9052 - Best Practices in Contracting for Models, Simulations, and Associated Data Mr. Dennis Shea, CNA	8947 - Report on a Study on Management Concepts for Broadly-Needed Modeling and Simulation Tools in the U.S. Department of Defense Dr. James Coolahan, Johns Hopkins University/APL
TRACK 2 Logistics Systems Bayview II	**Mr. Joel Moorvitch**, *Raytheon Company* and **Mr. Anthony Stampone**, *OSD-ATL*	9063 - An Integrated RAM Approach to System Design and Support Mr. Robert Finlayson, Johns Hopkins University/APL	9031 - Supportability Lessons Learned with Line Replaceable Modules Ms. Heity Hsiung, Raytheon Company	8908 - Successful First AESA Deployment through Application of System Engineering Mr. Scott Nichols, Raytheon Company	TRACK 2 Logistics Systems Bayview II	**Mr. Joel Moorvitch**, *Raytheon Company* and **Mr. Anthony Stampone**, *OSD-ATL*	8988 - How to Save Time and Money Using Lean Maintenance Processes Mr. Tim Olson, Lean Solutions Institute, Inc.	9039 - Applying Systems Engineering to Fielded Weapon Systems and End-Items Mr. Michael Ucchino, AF Center for Systems Engineering	9008 - Upgrade Fluid System Filter Element Monitoring To Increase Operational Reliability and Support Condition Based Maintenance Capability Mr. Gary Rosenberg, Constellation Technology Corportation
TRACK 1 Systems Engineering Effectiveness Bayview III	**Mr. Al Brown**, *The Boeing Company*	8887 - Achieving a Systems Engineering Culture in a Science and Technology Laboratory Environment Mr. Robert Rapson, Materials and Manufacturing Directorate, AFRL	8920 - A Methodology for Assessing Systems Engineering Practices Ms. Lauren Levy, Johns Hopkins University/APL	9097 - Acquisition ESOH Risk Management-How to Make It Work Mr. Bob Smith, Booz Allen Hamilton	TRACK 1 Architecture Bayview III	**Mr. Joe Kuncel**, *Northrop Grumman Corporation*	8831 - Human-Centered Design in Systems Engineering: Human View Methodology Dr. Robert Smillie, SPAWAR	8830 - Systems Engineering Needs of the DoDAF – Report of the Architecture Frameworks Working Group Mr. Joe Kuncel, Northrop Grumman Corporation	8824 - Delivering DoDAF Version 2.0 to Architects and Systems engineers for IT Systems and Services Mr. Walt Okon, Department of Defense CIO, Enterprise Architecture

THURSDAY, OCTOBER 29, CONCURRENT SESSIONS

TRACK	SESSION CHAIR	1:00 PM	1:35 PM	2:10 PM
TRACK 8 Software Intensive Systems Palm II	**Mr. Paul Croll,** *CSC* and **Mr. Scott Lucero,** *Systems Engineering Directorate, ODDR&E*	8802 - Open Source Technology for Enterprise Health Management Mr. Edward Beck, CSC	8901 - Review Results of the NDIA/OSD Software Test Summit/Workshop Mr. Thomas Wissink, Lockheed Martin IS&GS	9506 - Software Acquisition Management Practical Experience Mr. James Jones, SSAI 0000 - Implementing CMMI on a COTS Modification Effort Mr. Dave Castellano, U.S. Army
TRACK 7 Work Force Development Palm I	**Dr. Don Gelosh,** *Systems Engineering Directorate, ODDR&E* and **Mr. Mike Ucchino,** *U.S. Air Force Center for Systems Engineering*	8956 - Systems Engineering Approach to Workforce Development Mr. James Miller, U.S. Air Force	9046 - Developing an Introductory Systems Engineering Practitioners Course: "Model-Based Systems Engineering (MBSE) With SysML" Mr. Joseph Wolfrom, Johns Hopkins University/APL	8878 - Advanced Simulation Course for Army Simulation Management Professionals Dr. Gene Paulo, Naval Postgraduate School
TRACK 6 Enterprise Health Management Mission III	**Mr. Howard Savage,** *Savage Consulting* and **Mr. Chris Reisig,** *The Boeing Company*	8815 - Applying Systems Engineering to Operational System Improvements Ms. Ryanne Gentry, Acquisition Logistics Engineering	8842 - Applications in Integrated Diagnostics Mr. Jimmy Simmons, Georgia Tech Research Institute	8884 - Tactical Wheeled Vehicle Integrated Diagnostics Mr Lawrence Osentoski, DRIVE Developments, Inc.
TRACK 5 Systems Engineering Development Environment Mission II	**Mr. Al Brown,** *The Boeing Company*	8967 - Generating Visual and Interactive Output from System Engineering Tools Mr. John Schatz, Systems and Proposal Engineering Company	9015 - Challenges and Benefits of applying ISO STEP Mr. Stuart Booth, Systems Engineering Directorate, ODDR&E	9059 - Smallsat Conceptual Design Trade and Cost Modeling Tool Dr. Deganit Armon, Advatech Pacific, Inc
TRACK 4 Practical Systems Engineering Mission I	**Mr. Dana Peterson,** *DRS Technologies, Inc.*	8976 - A Systems Engineering Model for Roadmap Alignment Mr. Si Dok, U. S. Army TARDEC	9080 - Rapid Systems Engineering of the MRAP Gunner Restraint System Saves Lives Ms. Michelle Bowen, JPO MRAP	9002 - Key Considerations for Building Highly Available, Mission-Critical Systems Mr. Stephen Mills, GoAhead Software
TRACK 3 Modeling & Simulation Bayview I	**Mr. Jim Coolahan, JHU/APL**	8836 - Producibility Modeling & Simulation Needs for Early Systems Engineering Evaluations of Alternative Design Concepts Dr. Al Sanders, Honeywell Aerospace	8810 - Using Simulation to Define and allocate probabilistic Requirements Ms. Yvonne Bijan, Lockheed Martin Aeronautics	8923 - Integration of Operational Simulations With Physics-Based Models For Engineering Analysis Mr. Stephen Guest, Lockheed Martin Aeronautics
TRACK 2 Logistics Systems Bayview II	**Mr. Joel Moorvitch,** *Raytheon Company* and **Mr. Anthony Stampone,** *OSD-ATL*	8834 - Tailoring Systems Engineering for Technical Support of Legacy Products Mr. Joseph Skandera, BAE Systems	8837 - Injecting Requirements into Sustainment: UEWR RDA Mr. Jonathan Casey, Raytheon Integrated Defense Systems	9092 - The role of simulation in tracking mobile assets using RFID technology Mr. Swee Leong, National Institute of Standards and Technology
TRACK 1 Architecture Bayview III	**Mr. Joe Kuncel,** *Northrop Grumman Corporation*	9025 - Defining, Assessing, and Improving Architecture Competence Ms. Suzanne Garcia, Software Engineering Institute	8971 - Advancing Systems Engineering Practice using Model Based System Development Mr. Sanford Friedenthal, Lockheed Martin Corporation	9004 - Evolving Systems Engineering through Model Driven Functional Analysis Dr. Mark Blackburn, Systems and Software Consortium

2009 LT GEN THOMAS R. FERGUSON, JR. SYSTEMS ENGINEERING EXCELLENCE AWARD

The National Defense Industrial Association's Systems Engineering Excellence Awards were established in 2003 to honor the memory of Lt Gen Thomas R. Ferguson, Jr., USAF, whose leadership embodied the highest ideals in Defense Systems development and deployment.

The awards are given to an individual and to a group demonstrating outstanding achievement in the practical application of Systems Engineering principles, promotion of robust systems engineering principles throughout the organization, or effective systems engineering process development during the previous year. Their systems engineering contributions should have demonstrably helped achieve significant cost savings due to new or enhanced processes procedures and/or concepts, increased mission capabilities, or substantially increased performance. The 2009 awardees are:

- Systems Engineering Individual Leadership Award: *Mr. Brian Wells*
- Systems Engineering Group Award: *Center for Advanced Life Cycle Engineering*

PAST AWARD WINNERS:

2003:
- Systems Engineering Individual Leadership Award: *Mr. Robert Rassa*

2004:
- Systems Engineering Individual Leadership Award: *Honorable Mike Wynne*

2005:
- Systems Engineering Individual Leadership Award: *Mr. Mark Schaeffer*

2006:
- Systems Engineering Individual Leadership Award: *Mr. Kelly Miller*
- Systems Engineering Individual Practitioner Award: *Mr. David Strimling*
- Systems Engineering Group Award: *NUWC Division Newport Critical Transducer Program Staff*

2007:
- Systems Engineering Individual Leadership Award: *Mr. Robert Skalamera*
- Systems Engineering Group Award: *Submarine Warfare Federated Tactical SystemTeam*

2008:
- Systems Engineering Individual Leadership Award: *Honorable James Finley*
- Systems Engineering Group Award: *Tactical Direction Agent Team for LCS Mission Package Project*

DEPARTMENT OF DEFENSE AND THE NATIONAL DEFENSE INDUSTRIAL ASSOCIATION 2008 TOP 5 DEPARTMENT OF DEFENSE PROGRAM AWARDS

The Department of Defense Executive Agent for Systems Engineering and the Systems Engineering Division of the National Defense Industrial Association are pleased to announce the selections of the 2008 Top 5 Department of Defense Program Awards. The 2008 Program awardees are:

- *Wideband Global SATCOM: U.S. Air Force PM; Boeing Company Space & Intelligence Systems Group*
- *Joint Light Tactical Vehicle: U.S. Army/USMC PMs; BAE Systems Land & Armaments; General Tactical Vehicles; Lockheed Martin Systems Integration*
- *STRYKER Modernization: U.S. Army PM; General Dynamics Land Systems*
- *Broad Area Maritime Surveillance Unmanned Aircraft: U.S. Navy PM; Northrop Grumman Corporation*
- *Aviation Maintenance Training Continuum System: U.S. Navy PM; Raytheon Company; Paladin Data Systems Corporation*

The Awards are presented to both the DoD project office and the industry prime contractor in recognition of total program performance in a DoD/industry team effort.

PAST AWARD WINNERS:

2005 Top 5 Department of Defense Programs:

- *Centaur*
- *Integrated Exploitation Capability*
- *P-8A Multi Mission Maritime Aircraft*
- *Mission INtegration & Development*
- *Tomahawk Weapons System Program PMA-280*

2006 Top 5 Department of Defense Programs:

- *Advanced Extremely High Frequency Mission Control System*
- *Advanced Field Artillery Tactical Data System*
- *DDG 1000 MK57 Vertical Landing System*
- *Portable Excalibur FCS*

2007 Top 5 Department of Defense Programs:

- *Effects Management Tool*
- *MH-60 R/S Link 16*
- *Mortar Fire Control System - Dismounted*

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ADDITIONAL AUTHORS

Abstract ID	Abstract Title	Additional Authors
8736	The Method Framework for Engineering System Architectures (MFESA)	Mr. Donald Firesmith
8739	QUality Assessment of Software-Intensive System Architectures and their Requirements (QUASAR)	Mr. Donald Firesmith
8759	A Systems Engineering Framework for Integrating M&S Development Best Practices	Mr. Robert Lutz Shon Vick Nathaniel Horner
8770	Incorporating Maturity Assessment into House of Quality for Improved Decision Support Analysis and Risk Management	Mr. Pavel Fomin Dr. Shahram Sarkani Dr. Thomas Mazzuchi
8776	The Modular SOS Paradigm: an Availability Paradox?	Mr. Richard Volkert
8780	Net-Centric Best Practices	Mr. Higgin Ko
8789	Achieving Acquisition Excellence via Improving the Systems-Engineering Workforce	Dr. Kenneth Nidiffer
8791	Cost and Risk Impacts of the New DOD 5000 Defense Acquisition Framework	Ms. Nancy Kern
8795	Mission-based Test and Evaluation Strategy: Creating Linkages between Technology Development and Mission Capability	Mr. Christophre Wilcox
8801	Integrating Systems Engineering with Earned Value Management	Mr. Paul Solomon
8810	Using Simulation to Define and allocate probabilistic Requirements	Dr. Henson Graves
8814	Joint Mission Environment Test Capability (JMETC), Lowering technical Risk by Improving Distributed Test Capabilities	Mr. Ryan Norman
8815	Applying Systems Engineering to Operational System Improvements	Mr. Charles Coogan
8816	MIND THE GAPs-a Systems Engineering Implementation of DoDI 5000.02	Ms. Janet Jackson Mr. William Mejias Mr. Ccharles Fabian
8818	Integrated Testing enhances System Engineering. Presentation topics address the conference objectives of “Interoperability & System Integration” and “SE Effectiveness”; and the Topic Session of “T&E	Ms. Darlene Mosser-Kerner
8819	Rethinking Risk Management	Mr. Christopher Alberts
8820	Graduate Software Engineering Reference Curriculum (GSwERC)	Dr. Arthur Pyster Dr. Richard Turner Ms. Kahina Lasfer
8823	Win and Influence Design Engineers---Change Their Affordability DNA	Ms. Diane Patane
8825	Test and Evaluation in a System of Systems Environment	Dr. Shahram Sarkani Dr. Thomas Mazzuchi
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8833	Communicating Risk: Air Force RI3 Methodology	Mr. Gregory Barnette
8834	Tailoring Systems Engineering for Technical Support of Legacy Products	Mrs. Virginia Doyle Mr. Derrick Min
8837	Injecting Requirements into Sustainment: UEWR RDA	Noah Van Fossan
8839	Navy Systems Engineering Technical Review Process	Ms. Susan Lashomb
8842	Applications in Integrated Diagnostics	Mr. Tim Palmer
8849	Joint Integration and Interoperability Lab (JSIIL)	Mr. Martin Westphal Mrs. Margery Frisby Mr. Randy Coonts

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8854	Human Interoperability Enterprise and Net-Centric Operations	Dr. S. Brown Dr. Beverly Knapp
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8866	Extending FMECA to Systems of Systems	Mr. Clayton Smith
8874	The Boeing System of Systems Engineering (SoSE) Process and Its Use in Developing Legacy-Based Net-Centric Systems of Systems	Ms. Alaka Shivananda Mr. Dennis Schwarz Mr. Marion Butterfield
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8878	Advanced Simulation Course for Army Simulation Management Professionals	Stephanie Few
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8887	Achieving a Systems Engineering Culture in a Science and Technology Laboratory Environment	Dr. James Malas Mr. Bryan DeHoff Ms. Carol Ventresca
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8902	Systems Engineering Leading Indicators: Insight into Effective Systems Engineering	Mr. Gary Roedler
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8915	System of Systems Challenges and Solutions: Case Study Insights	Dr. David Jacques
8916	System Readiness - assessing technical risk throughout the lifecycle	Mr. Jim Thompson
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8923	Integration of Operational Simulations With Physics-Based Models For Engineering Analysis	Dr. William Graves
8924	Key Early Systems Engineering Activities and Products Under the New DoDI 5000.02	Dr. Don Gelosh
8929	Extending Net-Centric Quality of Service to Systems of Systems	Dr. John Colombi Dr. Kenneth Hopkinson Dr. Michael Grimaila
8931	The Role of Mentoring in Developing the Systems Engineering Workforce	Dr. Don Gelosh

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8935	Systems of Systems Systems Engineering and Test and Evaluation	Mr. John Palmer Dr. JoAnn Lane Mr. George Rebovich
8942	DoD Systems of Systems Update	Dr. William Asrat
8946	Protecting the Mission, Preserving Legacy and Promoting Growth	Kerri Van Horne
8947	Report on a Study on Management Concepts for Broadly-Needed Modeling and Simulation Tools in the U.S. Department of Defense	Dr. Katherine Morse Mr. Randy Saunders
8950	Live, Virtual, Constructive Architecture Roadmap: The Quest for Interoperability, Standards, and Reuse	Dr. Amy Henninger
8955	TUTORIAL: Early Systems Thinking and Technical Planning in Weapon System Concept Development (HALF DAY)	Ms. Robin Wright
8960	A Distillation of Lessons Learned from Complex System of Systems Acquisitions	Arthur Pyster Kenneth Kepchar Ann Teford Mark Weitekamp
8963	Air Force Concept Maturity Assessment	Mr. Jeff Loren
8966	Improving Systems Engineering Curriculum Using a Competency-Based Assessment Approach	Dr. Wiley Larson
8967	Generating Visual and Interactive Output from System Engineering Tools	Steven Dam Chris Ritter
8973	C-17 Transition to Criteria-based Airworthiness Certification	Mr. Michael McKinney
8974	Transforming Systems and Software Engineering Across an Enterprise	Mr. Timothy Chaill
8976	A Systems Engineering Model for Roadmap Alignment	Mr. John Fitch Ms. Harsh Desai
8980	Using Simulink and Model-driven Engineering Techniques for Integrated Flight Simulation Development	Brett Collins Jesse Carlaftes
8982	Systemic Root Cause Analysis – Driving Improvements into the Acquisition Process	Mr. Jim Thompson Mrs. Laura Dwinnell
8990	Systems Engineering for Rapid Capability Development	Ms. Kathleen Harger
8992	1/2 Day Tutorial: System of Systems (SoS) Quality Attribute Specification and Architecture Evaluation	Mr. William Wood Mr. Timothy Morrow Mr. John Klein
8996	Engineering Improvement in Software Assurance: A Landscape Framework	Dr. Carol Woody Christopher Alberts Andrew Moore
8998	Human Systems Integration – Ensuring the Human is Considered “Left of A”	Ms. Bridget Simpkiss
8999	Program Signature Measurement	Mr. Gordon Kranz Mr. Christopher Miller Mr. Gerald Tarasek
9003	CMMI for Executives	Mr. Wendell Mullison
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9007	Technology Maturation for the Automated Aerial Refueling (AAR) Project	Mr. Jacob Hinchman Mr. Daniel Schreiter Mr. Ba Nguyen Mr. Jordan Adams
9010	Network Enabled Weapons, A System Engineering Approach to Achieve Interoperabilty	Mr. Wyane Willhite

9012	Human Systems Integration: Defining and Validating a Framework for Enhanced Systems Development	Alisha Belk Dr. Robert Smillie Major Andrew Gepp, USMC
9014	SAVI: Aerospace Platform Development and Certification Using Modeling and Simulation to "Integrate, then Build"	Dr. Don Ward
9015	Challenges and Benefits of applying ISO STEP	Mr. Charlie Stirk
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9021	Critical Success Factors for Milestone Review Risk Identification	Dr. Jo Ann Lane
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9026	Early SE Determination of Best-Fit System Life Cycle Processes	Dr. Jo Ann Lane
9027	Department of Energy Office of Environmental Management's Technology Readiness Assessment (TRA) Process	Mr. Kurt Gerdes Dr. Steven Krahn Dr. Herbert Sutter
9031	Supportability Lessons Learned with Line Replaceable Modules	Mr. Joel Moorvitch
9034	SUSTAINMENT AND CONTINUED INSTITUTIONALIZATION OF BEST PRACTICES AND CMMI® AT SPAWAR	Mr. Michael Knox
9035	Enabling Collaborative Decision Making: A Process for Integrating Novel Systems Engineering Tools and Methods for Renewable Energy Portfolio Analysis	Mr. Thomas McDermott
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9043	Implementing the Materiel Availability KPP in DoD acquisition programs—balancing life-cycle costs with warfighter needs	Mr. Pete Nolte Mr. John Quackenbush
9046	Developing an Introductory Systems Engineering Practitioners Course: "Model-Based Systems Engineering (MBSE) With SysML"	Mr. Michael Pafford
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9060	Modeling and Simulation Support for the Systems Engineering of Systems of Systems (short title "M&S Support for SoS SE")	Dr. William Asrat
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9104	Static Code Analysis: Best Practices for Software Assurance in the Acquisition Life Cycle	Mr. Paul Croll

***QU**ality **A**ssessment of **S**ystem **A**rchitectures and their **R**equirements (QUASAR) Version 3.1*

Donald Firesmith
Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213

NDIA 12th Annual Systems Engineering Conference
29 October 2009

Topics

Requirements and Architecture Challenges

Underlying Concepts

QUASAR Method

Reasons to use QUASAR

Requirements and Architecture Challenges[1]

Requirements and Architecture are the first two Opportunities to make Major Engineering Mistakes.

Architecturally Significant Requirements are typically poorly engineered.

Architecture and associated Architecturally Significant Requirements Affect:

- Project Organization and Staffing (Conway's Law)
- Downstream Design, Implementation, Integration, Testing, and Deployment Decisions

A common project-specific Quality Model is needed to drive the

- Quality Requirements, which drives the
- Quality of the System Architecture, which drives the
- Quality of the System

Requirements and Architecture Challenges$_2$

Architecturally-Significant, Quality-Related Requirements and their associated Architectural Decisions *Drive* the System and Component:

- Ultimate Quality
- Development Schedule
- Development Costs
- Sustainment Costs
- Maintainability and Upgradeability
- Acceptance and Usage by Stakeholders

Requirements and Architecture Challenges$_3$

It is important to identify (and thereby help Manage) Risks:

- Requirements and Architecture Risks
- System and Project Risks
- Business Risks

It is important to provide Acquirer/Management:

- *Visibility* into
- *Oversight* over

the System and Component Requirements and Architecture

It is important to determine *Compliance*:

- Requirements and Architecture with Contract (Acquirer) Requirements
- Architecture with System and Component (Developer) Requirements

Topics

Requirements and Architecture Challenges

Underlying Concepts

QUASAR Method

Reasons to use QUASAR

What is Quality?

Quality

the Degree to which a Work Product (e.g., System, Subsystem, Requirements, Architecture) Exhibits a Desired or Required Amount of Useful or Needed Characteristics and Attributes

Not just lack of defects!

Question:

What Types of Characteristics and Attributes are these?

Answer:

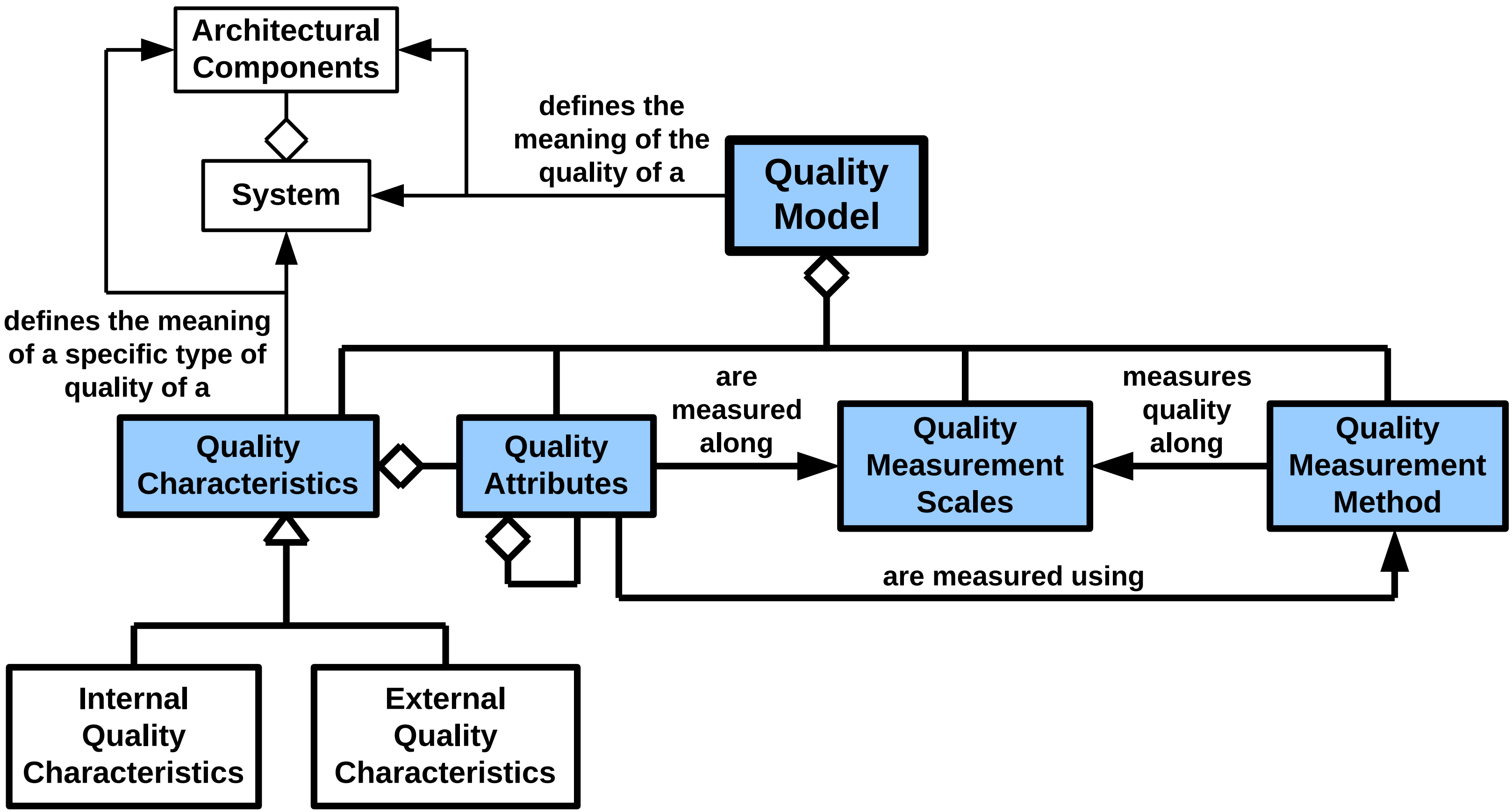
They are the Characteristics defined by the Project Quality Model.

Quality Model$_1$

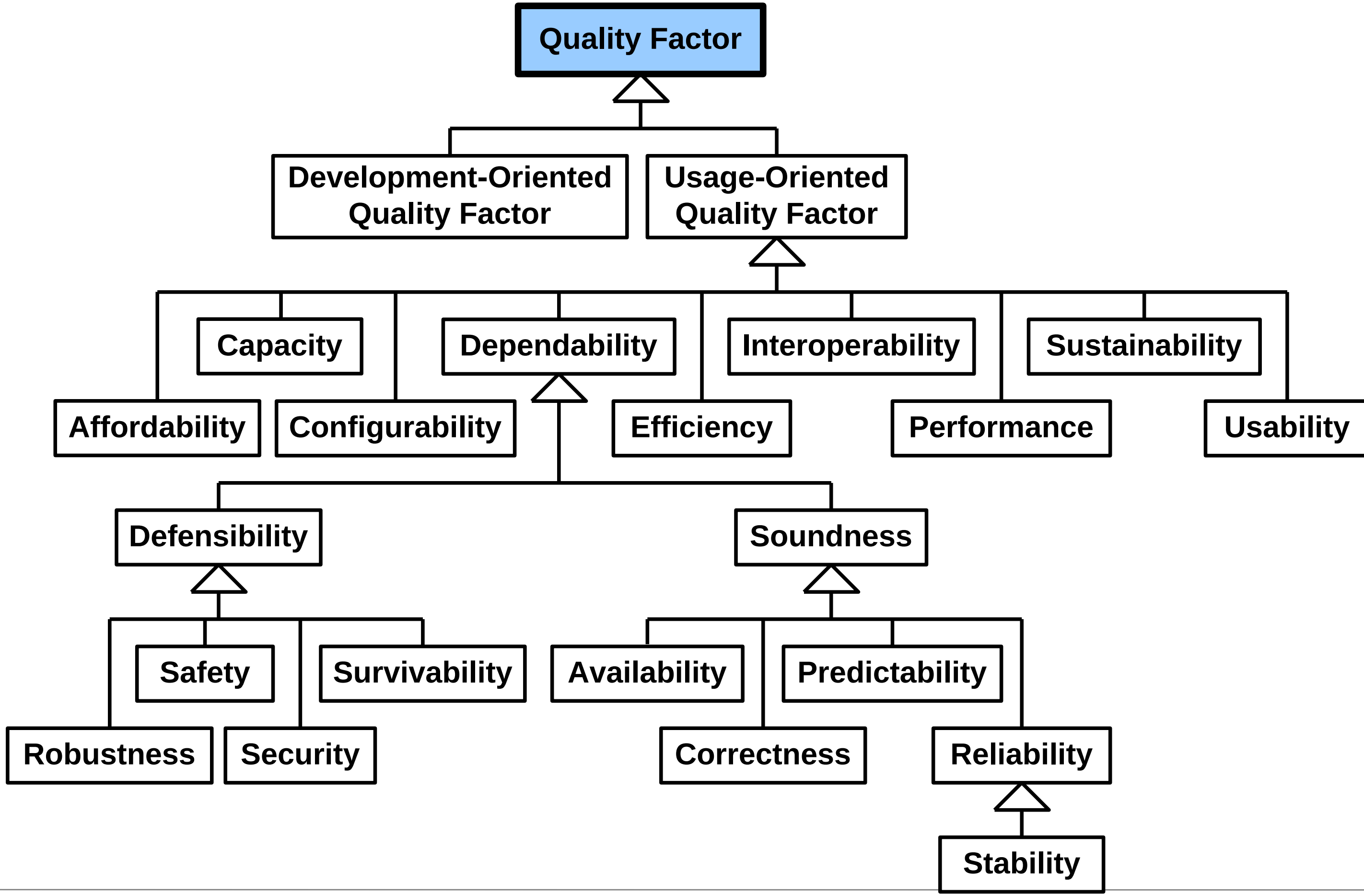
Quality of a Work Product is defined in terms of a **Quality Model**:

- **Quality Characteristics**
(a.k.a., Quality Factors, the ‘ilities’)
(e.g., availability, extensibility, interoperability, maintainability, performance, portability, reliability, safety, security, and usability)
- **Quality Attributes**
(a.k.a., Quality Subfactors)
(e.g., the quality attributes of performance are jitter, latency, response time, schedulability, throughput)
- **Quality Measurement Scales**
(e.g., milliseconds, transactions per second)

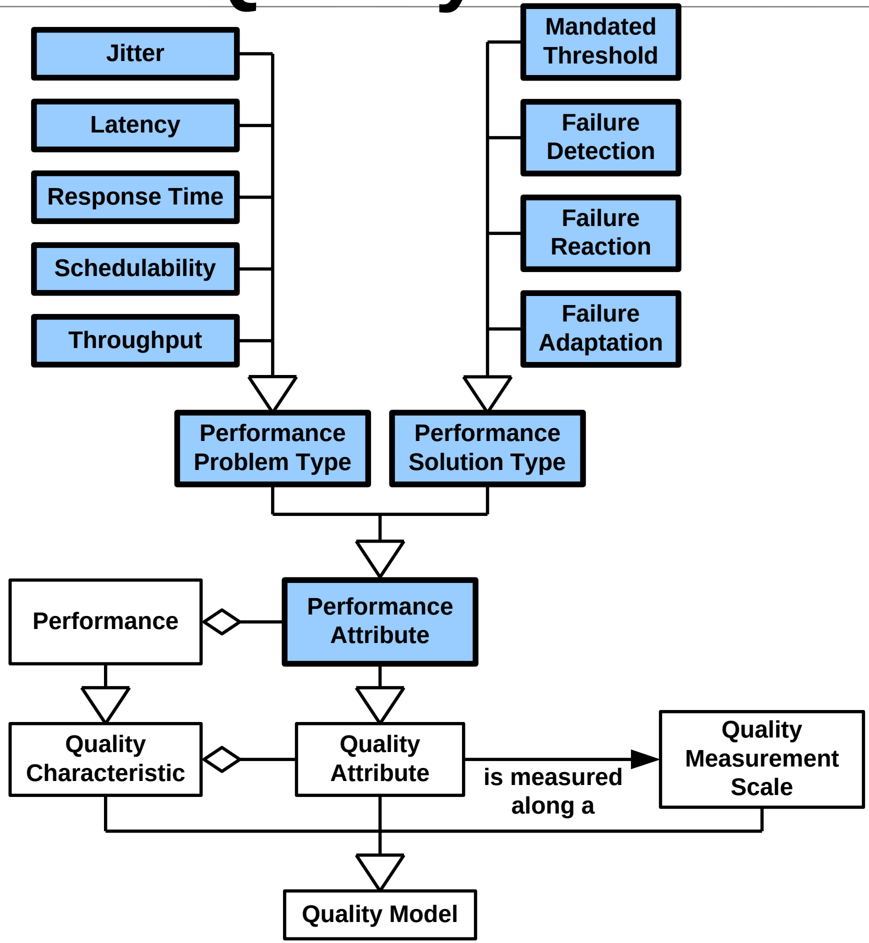
Quality Model$_2$



Quality Model – Quality Characteristics



Quality Model – Performance Quality Attributes



Quality Case - Definition

Quality Case

a Cohesive Collection of *Claims*, *Arguments*, and *Evidence* that Makes the Developers' Case that their Work Product(s) have *Sufficient Quality*

Foundational Concept underlying QUASAR

A Generalization and Specialization of Safety Cases from the Safety Community:

More) Can Address any Quality Characteristic and/or Quality Attribute

Less) May be Restricted to only Requirements or Architecture

Useful for:

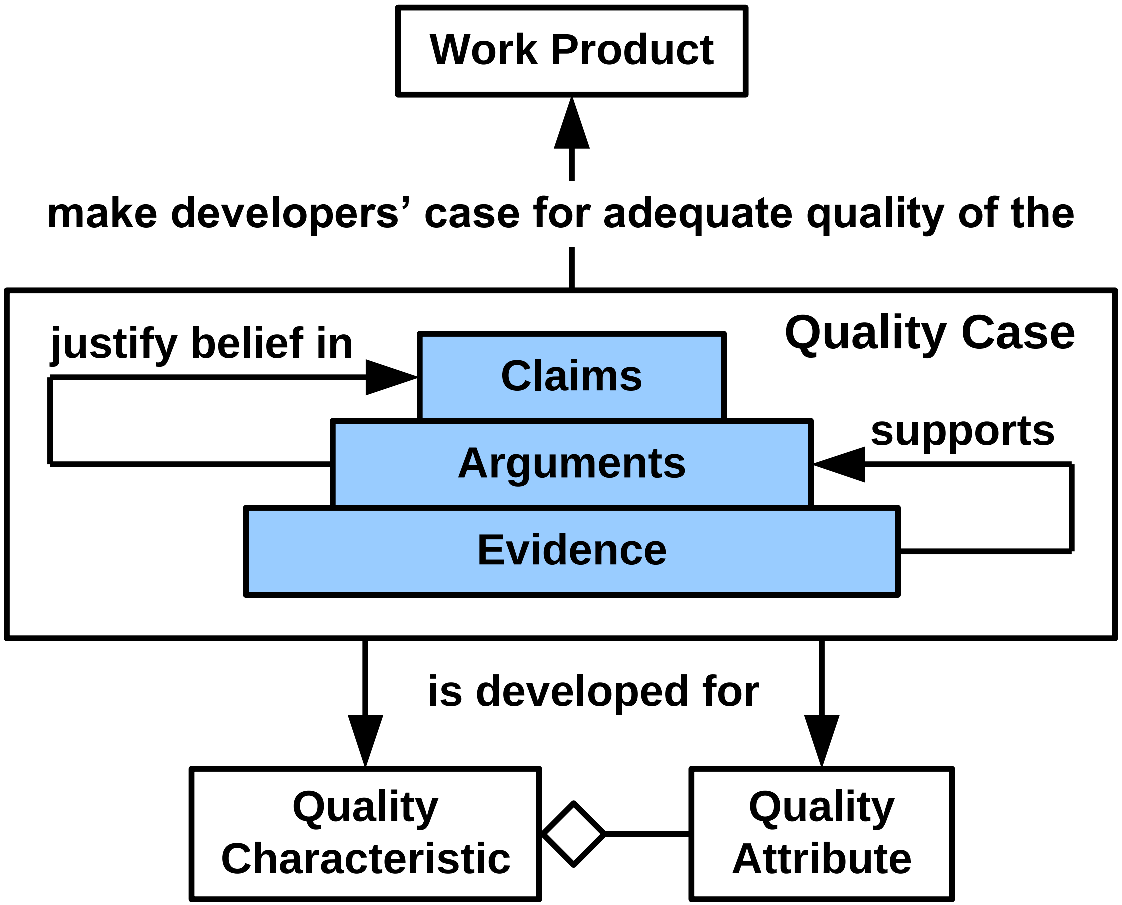
- Assessing Quality
- System Certification and Accreditation (e.g., safety and security)

Quality Cases – Components$_1$

A Quality Case consists of the following types of Components:

1. **Claims**
   Developers' Claims that their Work Products have *Sufficient* Quality, whereby quality is defined in terms of the qualify characteristics and quality attributes defined in the official project quality model
2. **Arguments**
   Clear, Compelling, and Relevant Developer Arguments Justifying the Assessors' Belief in the Developers' Claims
   (e.g., decisions, inventions, trade-offs, analysis and simulation results, assumptions, and associated rationales)
3. **Evidence**
   Adequate Credible Evidence Supporting the Developers' Arguments (e.g., official project diagrams, models, requirements specifications and architecture documents; requirements repositories; analysis and simulation reports; test results; and demonstrations witnessed by the assessors)

Quality Cases – Components$_2$



Specialized QUASAR Quality Cases

QUASAR utilizes the following specialized types of Quality Cases:

1. Requirements Quality Cases
2. Architectural Quality Cases

QUASAR Version 1 only had Architectural Quality Cases.

QUASAR Versions 2 and 3 have Both Types of Quality Cases.

QUASAR Quality Case Responsibilities

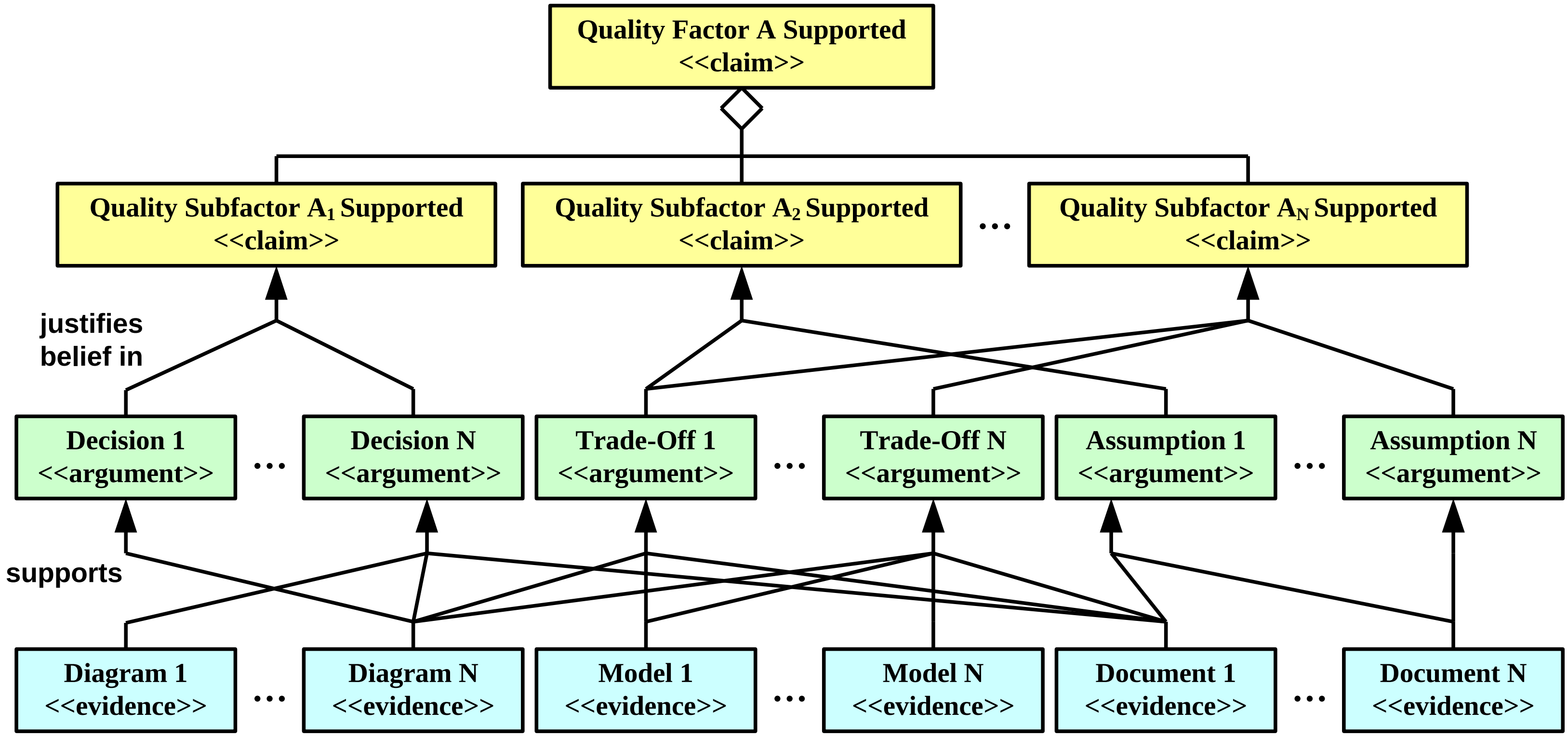
Requirements Engineers and Architects' Responsibilities:

- Prepare Quality Cases
- Provide Preparation Materials (including Presentation Materials and Quality Cases) to Assessors Prior to Assessment Meetings
- Present Quality Cases (Make their Case to the Assessors)
- Answer Assessors' Questions

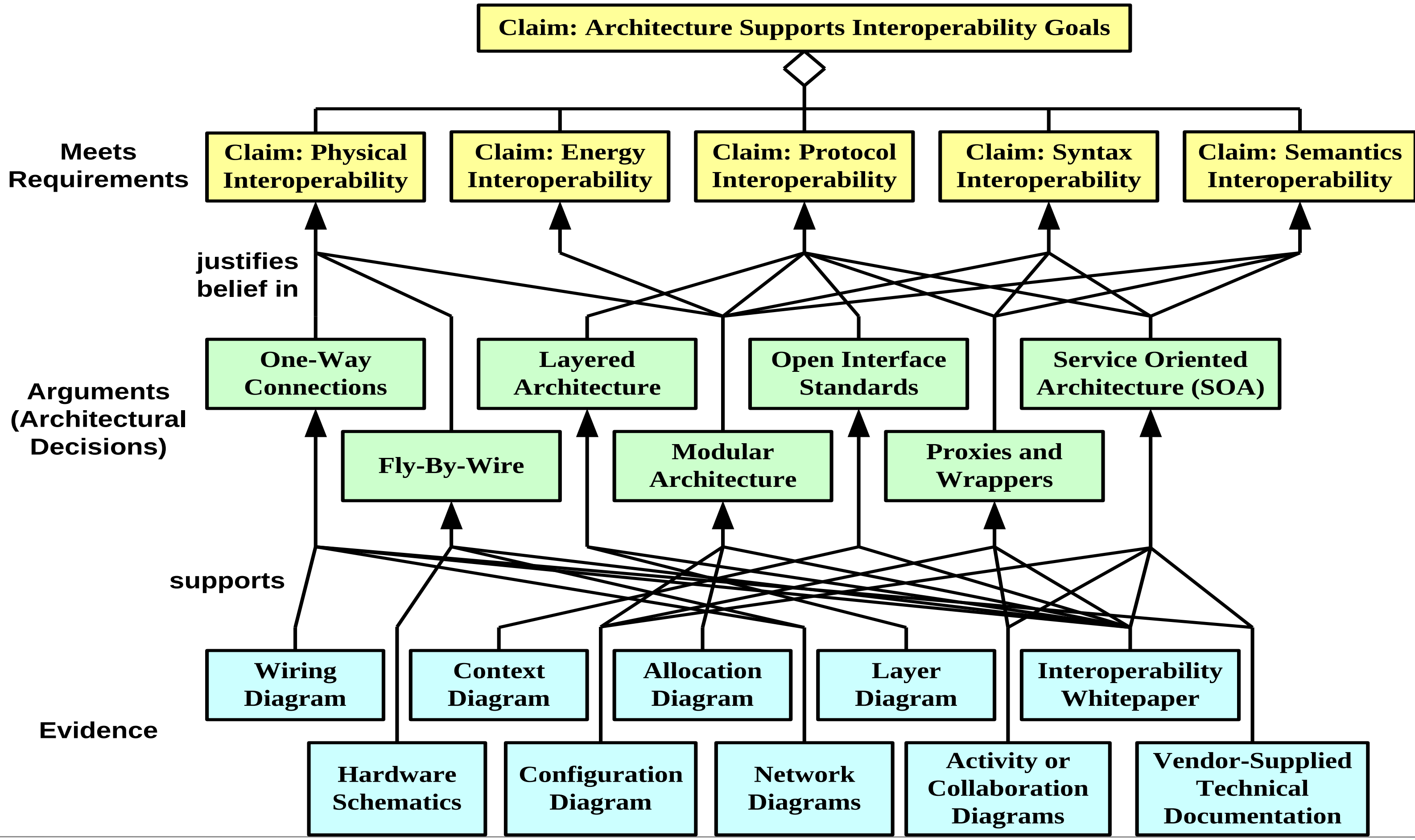
Assessor Responsibilities:

- Prepare for Assessments
- *Actively* Probe Quality Cases
- Develop Consensus regarding Assessment Results
- Determine and Report Assessment Results:
  - Present Outbriefs
  - Publish Reports

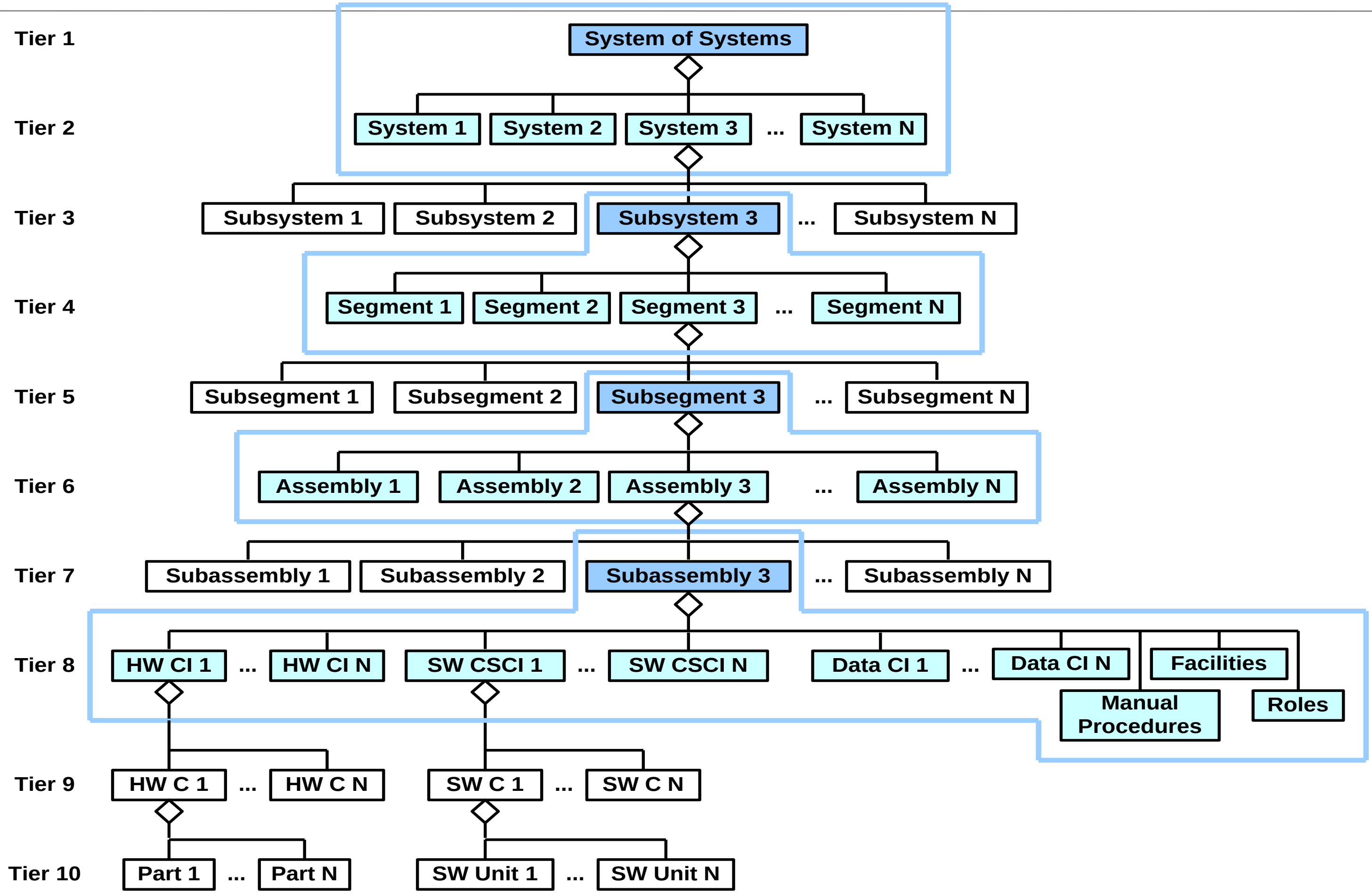
Quality Case Diagram Notation



Architectural Interoperability Case Diagram



Example QUASAR Scope – Four Assessments



What is a System Architecture?$_1$

System Architecture

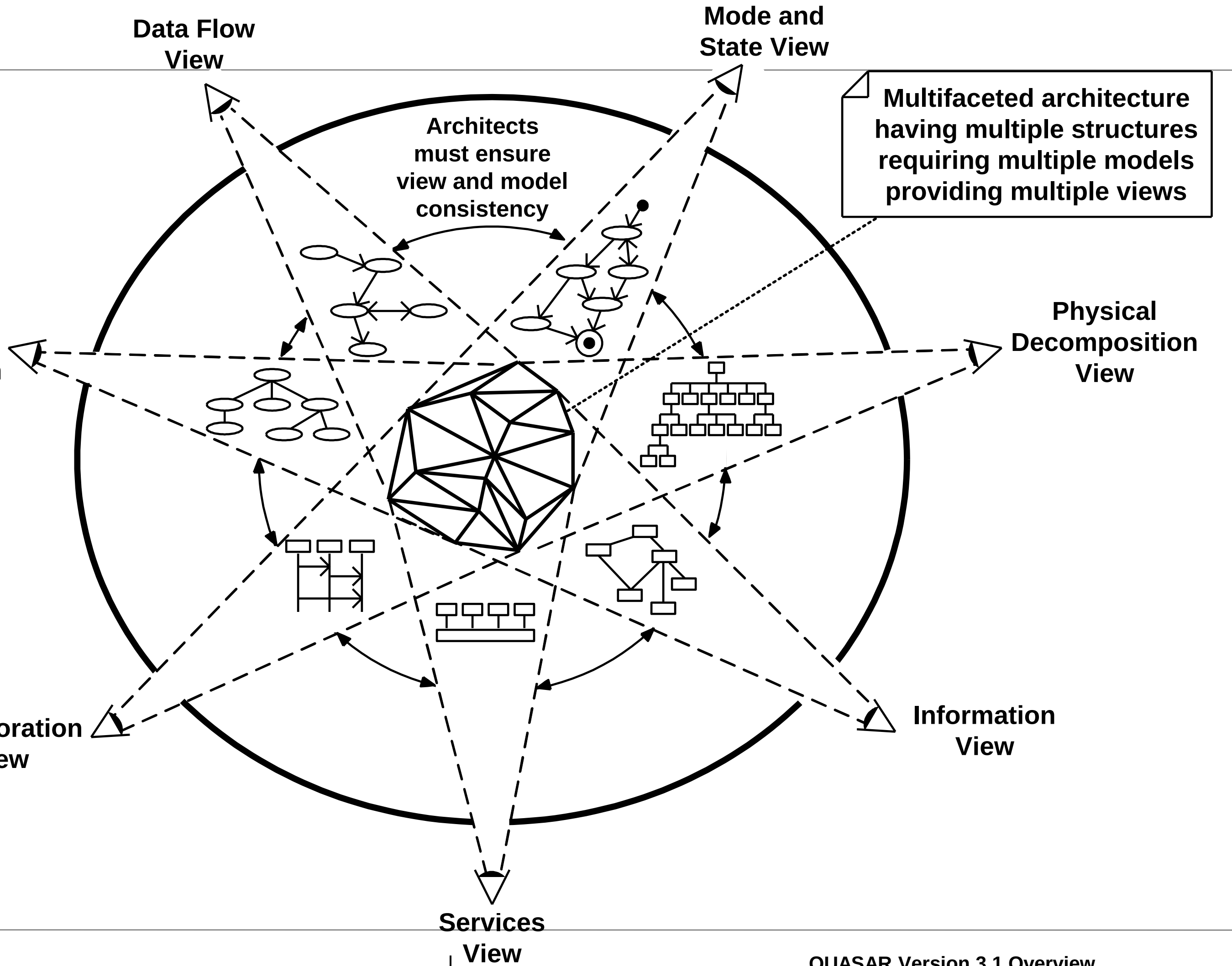
the *Most Important, Pervasive, Top-Level, Strategic Decisions, Inventions, Engineering Trade-Offs, Assumptions,* and associated *Rationales* about *How* a System's Architectural Elements will collaborate to meet the System's Derived and Allocated Requirements

What is a System Architecture?$_2$

System Architecture Includes:

- **The System's Numerous Static and Dynamic, Logical and Physical Structures**
  (i.e., Essential Architectural Elements, their Relationships, their Associated Blackbox Characteristics and Behavior, and how they Collaborate to Support the System's Mission and Requirements)
- **Architectural Decisions, Inventions, and Tradeoffs**
  (e.g., Styles, Patterns, and Mechanisms used to ensure that the System Achieves its Architecturally-Significant Product and Process Requirements (esp. Quality Requirements or 'ilities')
- **Strategic and Pervasive Design-Level Decisions**
  (e.g., using a *Design* Paradigm such as Object-Orientation or Mandated Widespread use of common Design Patterns)
- **Strategic and Pervasive Implementation-Level Decisions**
  (e.g., using a Safe Subset of C++)

Some Example Views of Models of Structures



Architecture vs. Design

Architecture	Design
Pervasive (Multiple Components)	*Local* (Single Components)
Strategic Decisions and Inventions	*Tactical* Decisions and Inventions
Higher-Levels of System	*Lower-Levels* of System
Huge Impact on Quality, Cost, & Schedule	*Small Impact* on Quality, Cost, & Schedule
Drives Design and Integration Testing	*Drives* Implementation and Unit Testing
Driven by Requirements and Higher-Level Architecture	*Driven by* Requirements, Architecture, and Higher-Level Design
Mirrors Top-Level Development Team Organization (Conway's Law)	*No* Impact on Top-Level Development Team Organization

Architectural Documentation Current-State

System Architecture Documents:

- Mostly natural language Text with Visio-like Diagrams (Cartoons)
- Logical (functional) and Physical Architecture

DOD Architecture Framework (DODAF):

- All-Views, Operational Views, Systems Views, and Technical Standards Views for allocating Responsibilities to Systems and Supporting System Interoperability

Models (both static and dynamic; logical and physical):

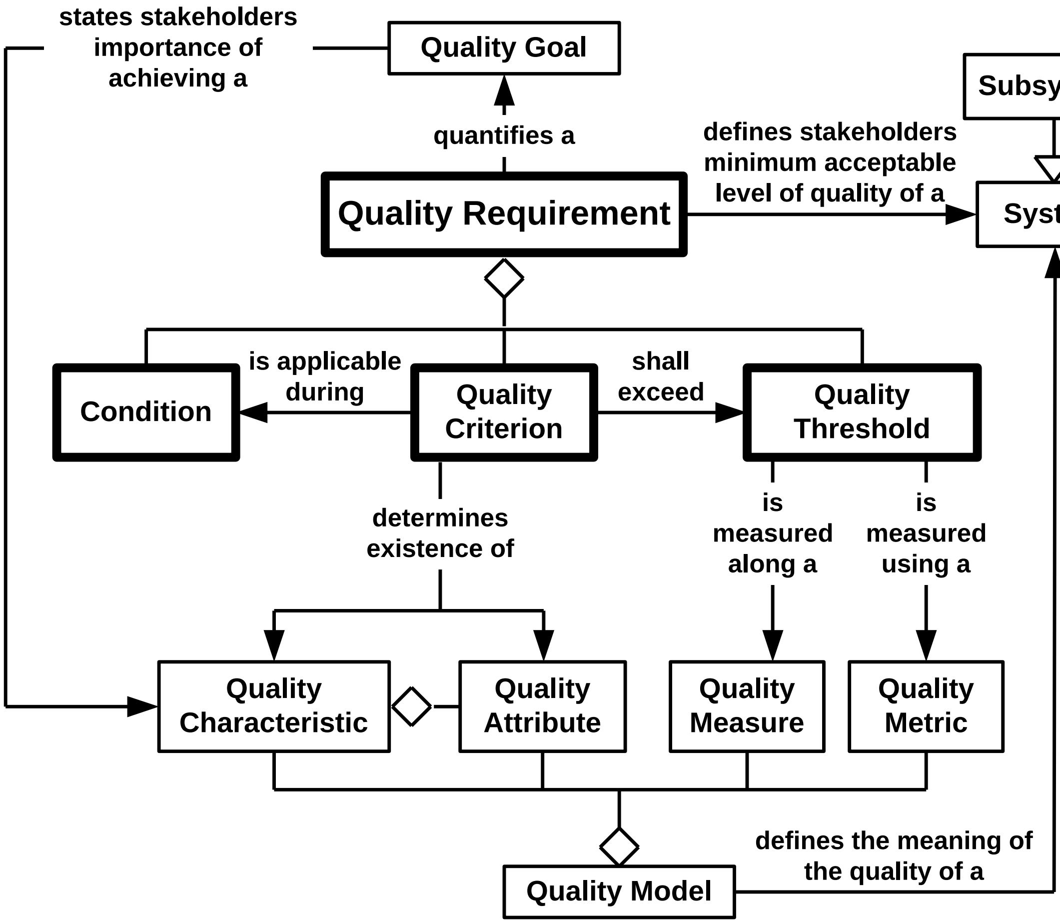
- Tailored UML becoming *de facto* Industry Standard
- SysML starting to become Popular

Visio Diagrams as Wall Posters

Whitepapers, Reports, and other Specialty-Engineering Documents:

- Performance, Fault Tolerance, Reliability, Safety, Security

Quality Requirements – Components



Topics

Requirements and Architecture Challenges

Underlying Concepts

QUASAR Method

Reasons to use QUASAR

Definition

QUality Assessment of System Architectures and their Requirements

a Well-Documented and Proven Method based on the use of *Quality Cases* for *Independently* Assessing the *Quality* of:

- Software-intensive *System* / Subsystem *Architectures* and the
- *Architecturally Significant Requirements* that Drive Them

QUASAR Philosophy$_1$

Informal *Peer Reviews* are Inadequate:

- Too Informal
- Lack of *Independent* Expert Input
- Requirements and Architecture are too Important

Quality Requirements:

- Most important Architecturally-Significant Requirements
- Largely Drive the System Architecture
- Criteria against which the System Architecture is Assessed

QUARSAR Philosophy$_2$

Requirements Engineers (REs) should *Make Case* to Assessors:

- REs *should* know Stakeholder Needs and Goals
- REs *should* know What they Did and Why (Architecturally-Significant Requirements, Rationales, & Assumptions)
- REs *should* Know Where they Documented their Requirements Work Products

Architects should *Make Case* to Assessors:

- Architects *should* know Architecturally-Significant Requirements
- Architects *should* know What they Did and Why (Decisions, Inventions, Trade-Offs, Assumptions, and Rationales)
- Architects *should* know Where they Documented their Architectural Work Products

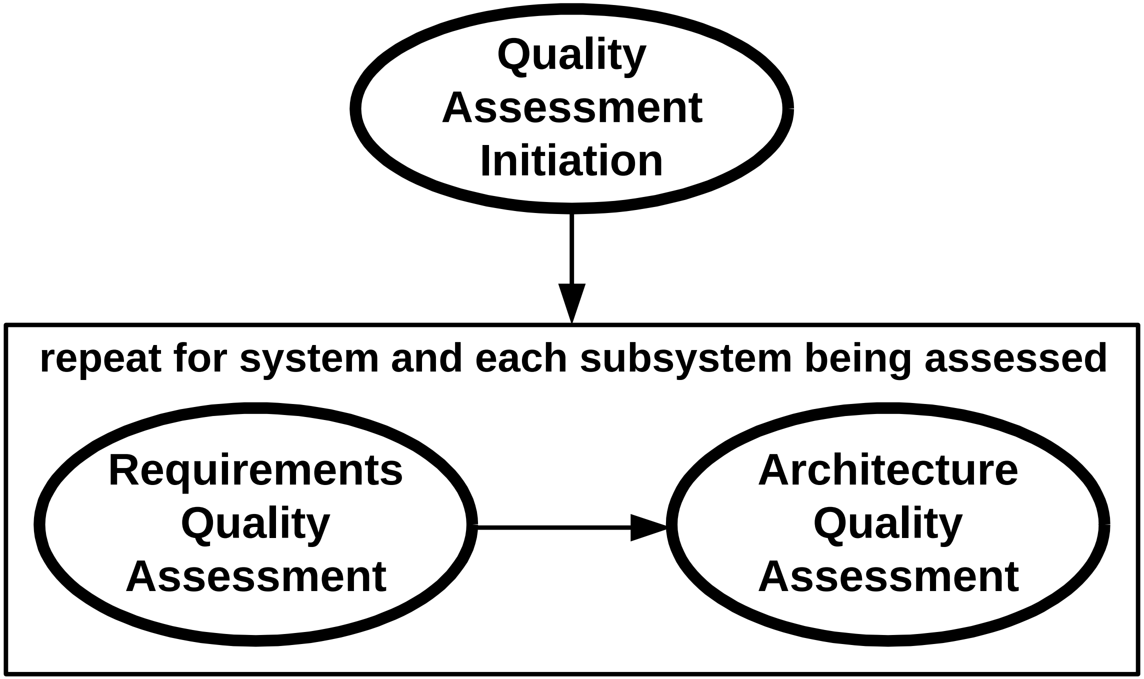
QUASAR Philosophy$_3$

Assessors should *Actively* Probe Quality Cases:

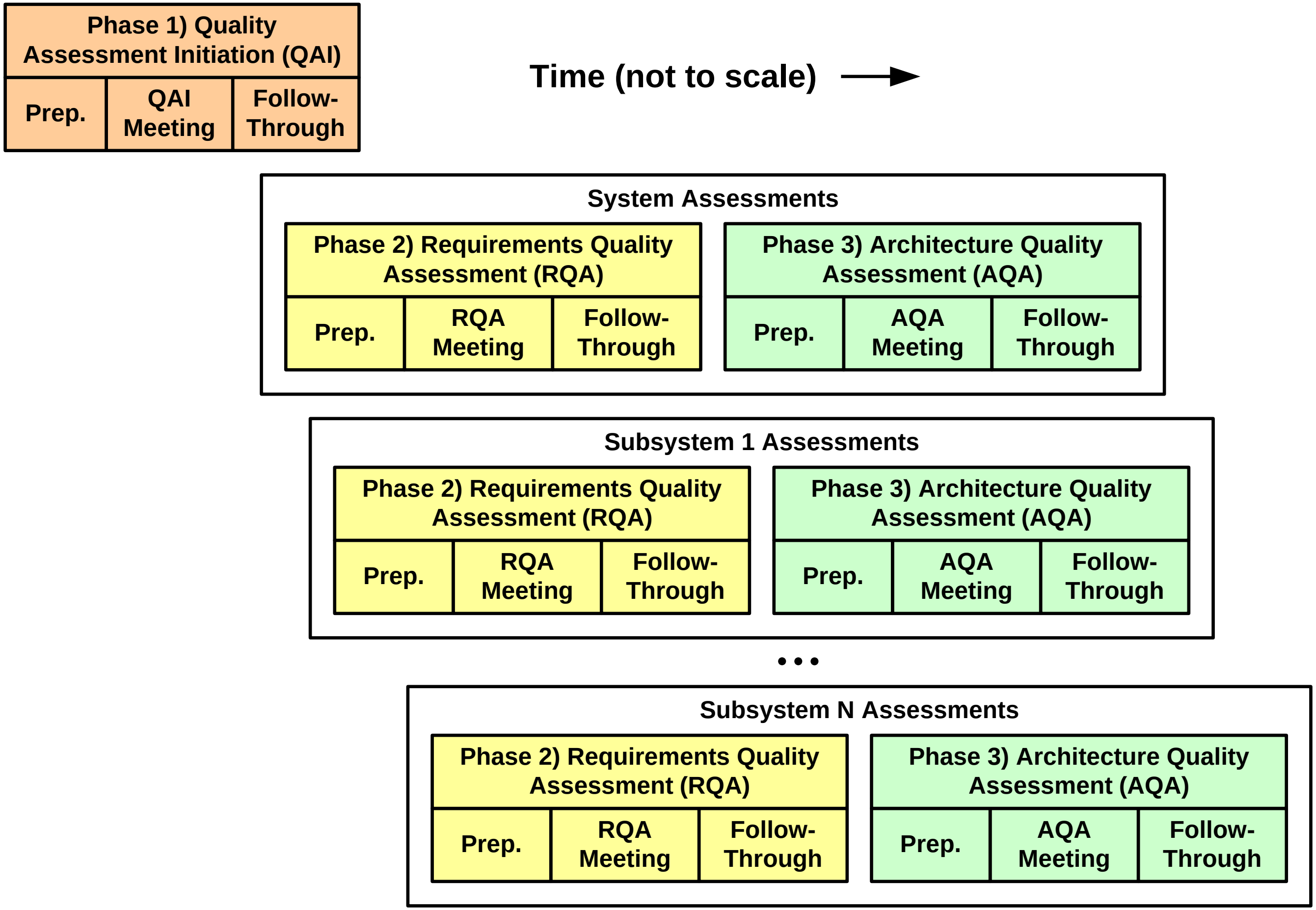
- **Claims Correct and Complete?**
  Do the Claims include *all* relevant Quality Characteristics, Quality Attributes, Quality Goals, and Quality Requirements?
- **Arguments Correct, Complete, Clear, and Compelling?**
  Do the Arguments include *all* relevant Quality Characteristics, Quality Attributes, Quality Goals, Quality Requirements, Decisions, Inventions, Trade-offs, Assumptions, and Rationales?
- **Arguments Sufficient?**
  Are the Arguments Sufficient to Justify the Claims?
- **Evidence Sufficient?**
  Is the Evidence Sufficient to Support the Arguments?
- **Current Point in the Schedule?**
  Are the Claims, Arguments, and Evidence appropriate for the Current Point in the Schedule?

QUASAR Method – Three Phases

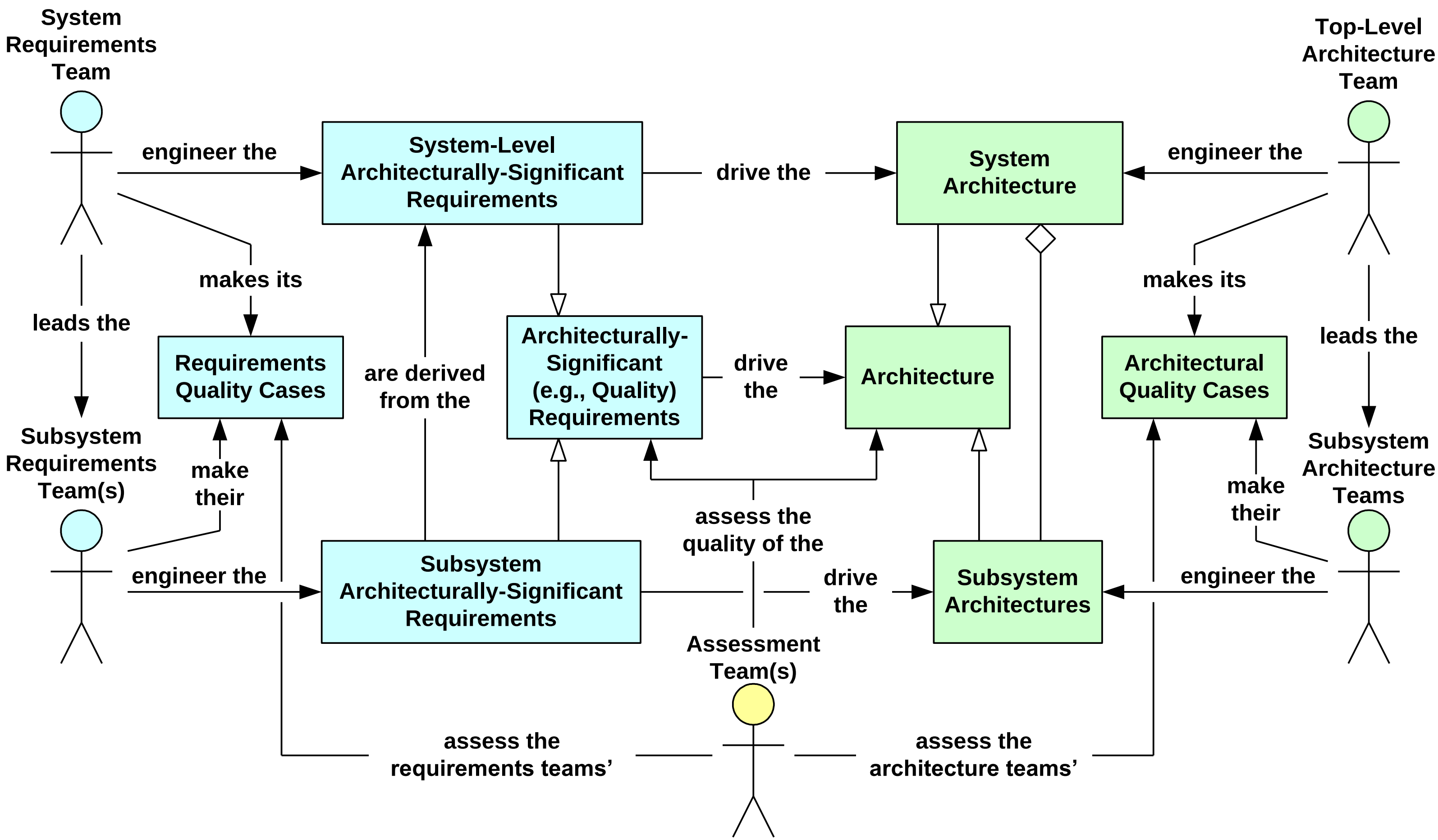
1. Quality Assessment Initiation (QAI)
2. Requirements Quality Assessment (RQA)
3. Architecture Quality Assessment (AQA)



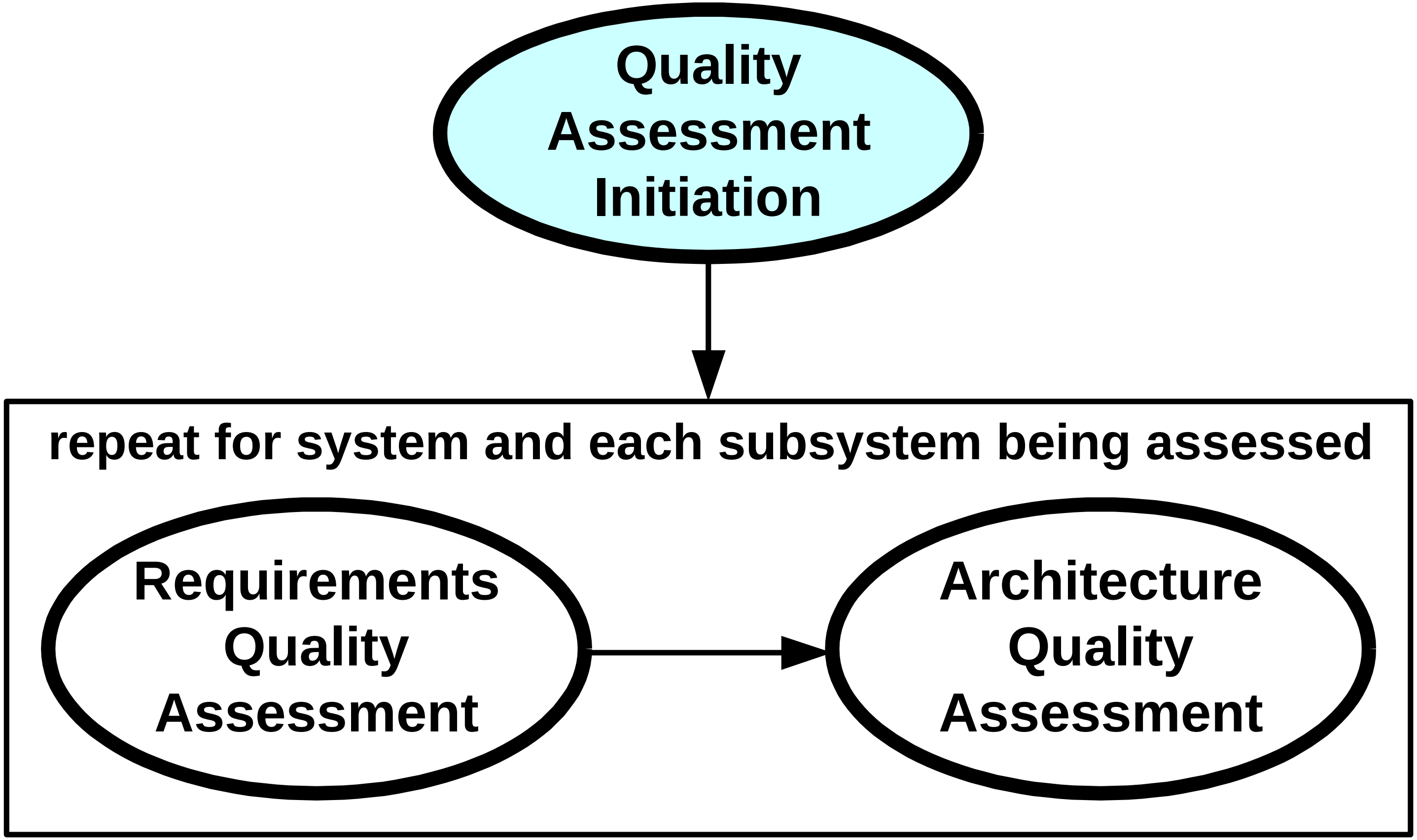
QUASAR Phases and Tasks



Quasar Teams and their Work Products



Quality Assessment Initiation (QAI)



Phase 1) QAI – Objectives

Prepare Teams for Requirements and Architecture Assessments

Develop Consensus:

- Scope of Assessments
- Schedule Assessments
- Tailor the Assessment Method and associated Training Materials

Produce and Publish Meeting Outbrief and Minutes

Manage Action Items

Capture Lessons Learned

Tailor/Update QUASAR Method and Training Materials

Phase 1) QAI – Preparation Task

1. Management Team staffs Assessment Team
2. Process and Training Teams train Assessment Team
3. Assessment Team identifies:
   - System Requirements Team
   - System Architecture Team
4. Process and Training Teams train System Requirements and Architecture Teams
5. Assessment, Requirements, and Architecture Teams collaborate to Organize QAI Meeting (i.e., Attendees, Time, Location, Agenda)

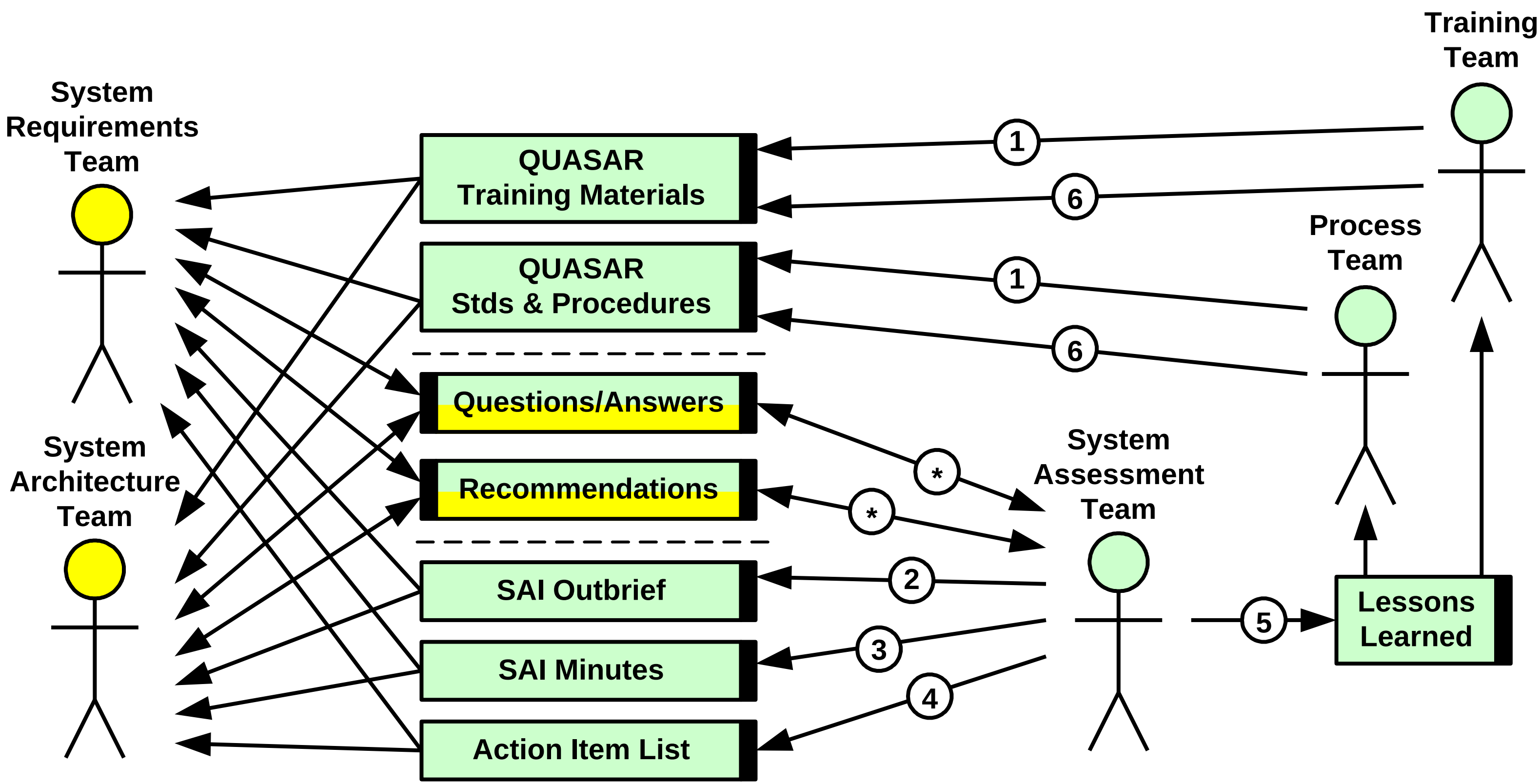
Phase 1) QAI – Meeting Task

1. Assessment, System Requirements, and System Architecture Teams Collaborate to determine Assessment Scope:
   - Subsystems/Architectural Elements/Focus Areas to Assess (Number and Identity)
   - Quality Characteristics and Quality Attributes underlying Assessment
   - Assessment Resources (e.g., Staffing, Schedule, and Budget)
2. Teams Collaborate to develop Initial Assessment Schedule with regard to System schedule, Subsystem schedule, and associated milestones
3. Teams Collaborate to tailor QUASAR Method
4. Assessment Team captures Action Items

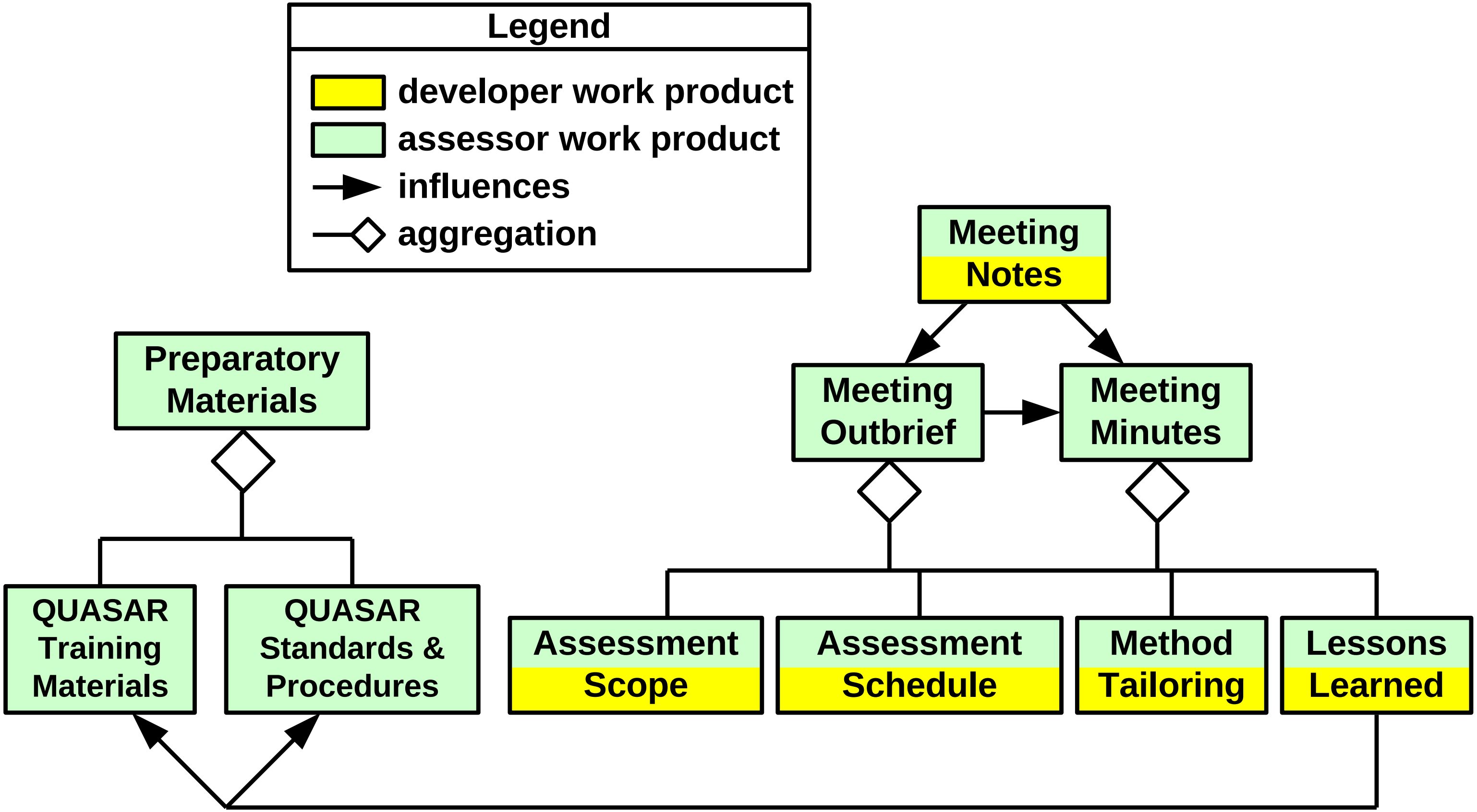
Phase 1) QAI – Follow-Through Task

1. Assessment Team develops and presents Meeting Outbrief
2. Assessment Team develops, reviews, and distributes Meeting Minutes
3. Assessment/Process/Training Teams tailor, internally review, and distribute:
   - QUASAR Procedure, Standards, and Templates
   - QUASAR Training Materials
4. Teams distribute Assessment Schedule
5. Teams obtain Needed Resources
6. Assessment Team Manages Action Items
7. Assessment Team captures Lessons Learned

Phase 1) QAI – Work Product Flow



Phase 1) QAI – Work Products



Phase 1) QAI – Lessons Learned$_1$

Ensure Appropriate Team Memberships (e.g., Authority)

Ensure Adequate Resources (e.g., Staffing, Budget, and Schedule)

Obtain Consensus on:

- Assessment Objectives and Scope
- Definitions (e.g., of Quality Characteristics, Attributes, and Cases)

Provide Early Training:

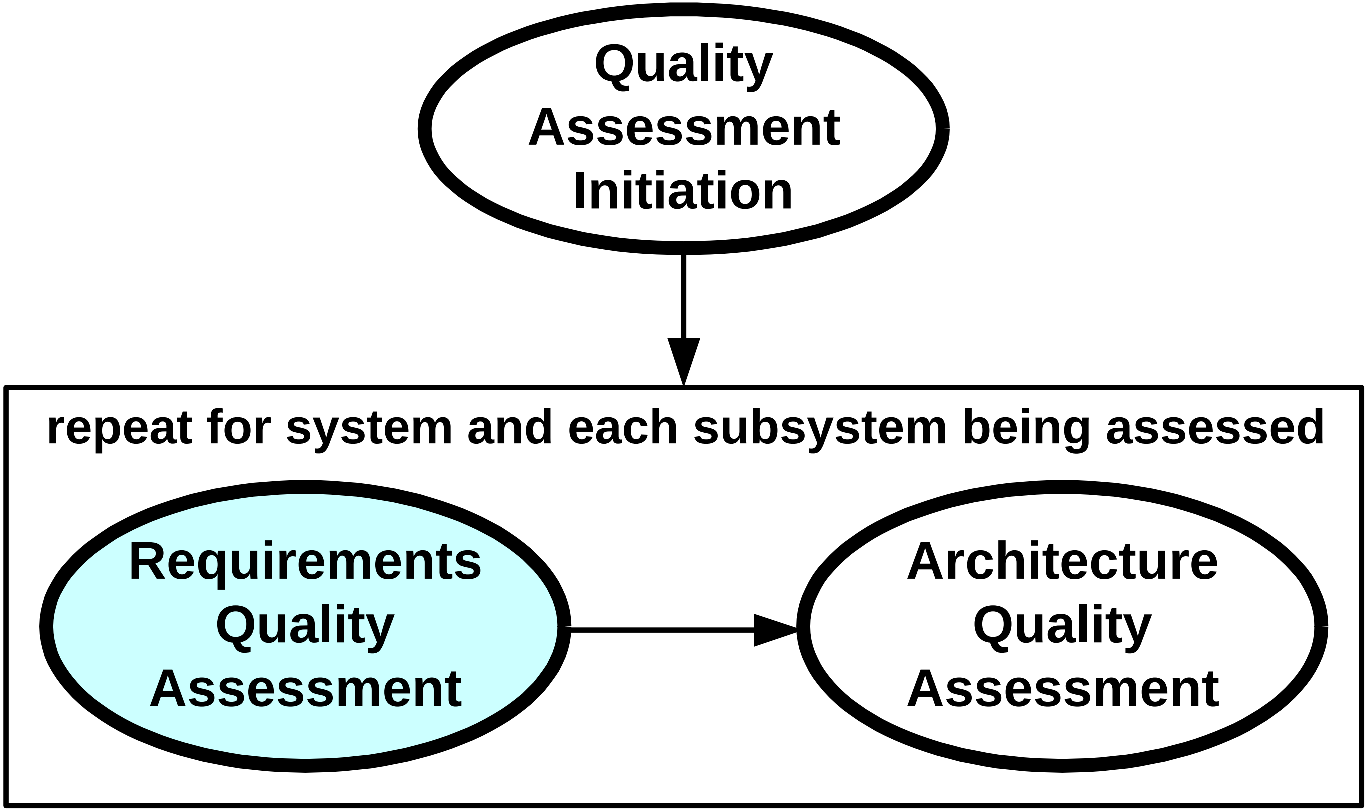
- Method Training
  (QUASAR, Requirements Engineering, and Architecting)
- System/Subsystem Training
  (Requirements and Architecture)

Phase 1) QAI – Lessons Learned$_2$

QUASAR assessments should be Organized according to a Quality Model that defines Quality Characteristics (a.k.a., factors, “ilities’) and their Quality Attributes such as:

- Availability
- Interoperability
- Performance
  - Jitter, Response Time, Schedulability, and Throughput
- Portability
- Reliability
- Safety
- Security
- Usability

Requirements Quality Assessment (RQA)



Phase 2) ARA – Objectives$_1$

Use Requirements Quality Cases to:

- Independently assess Quality and Maturity of the Architecturally Significant Requirements:
  - Drive the Architecture
  - Form Foundation for Architecture Quality Assessment
- Help Requirements Engineers identify Requirements Defects and Weaknesses so that:
  - Defects and Weaknesses can be Corrected
  - The Architecture (and System) can be Improved

Phase 2) RQA – Objectives$_2$

Use Requirements Quality Cases to:

- Identify Requirements Risks so that they can be Managed
- Provide Visibility into the Status and Maturity of the Requirements
- Increase the Probability of Project Success

Ensure Architecture Team will be Prepared to Support the coming Architecture Quality Assessment.

Capture Lessons Learned.

Update QUASAR Method and associated Training Materials.

Phase 2) RQA – Preparation Task

Process/Training Team trains the Requirements and Architecture Teams *significantly prior* to the RQA Meeting.

Requirements and Architecture Teams provide Preparatory Materials to the Quality Assessment Team *significantly prior* to the RQA Meeting:

- Summary Presentation Materials
- Requirements Quality Cases
  (including electronic access to evidentiary materials)
- Example of Planned Architectural Quality Case

Quality Assessment Team:

- Reads Preparatory Materials
- Generates RFIs and RFAs

Phase 2) RQA – Meeting Task

1. Requirements Team presents:
   - System Overview
   - Requirements Overview
   - *Requirements* Quality Cases
2. Quality Assessment Team assesses Quality and Maturity of Requirements:
   - Completeness of Quality Cases
   - Quality of Quality Cases
3. Architecture Team presents Example Architectural Quality Case
4. Quality Assessment Team recommends Improvements
5. Quality Assessment Team manages Action Items

Phase 2) RQA – Follow-Through Task

Quality Assessment Team:

1. Develops Consensus Regarding Requirements Quality
2. Produces, Reviews, and Presents Meeting *Outbrief*
3. Produces, Reviews, and Publishes RQA *Report*
4. Updates and publishes the System Quality Assessment Summary Matrix
5. Captures Lessons Learned
6. Manages Action Items

Requirements Team:

Addresses Risks Raised in RQA Report

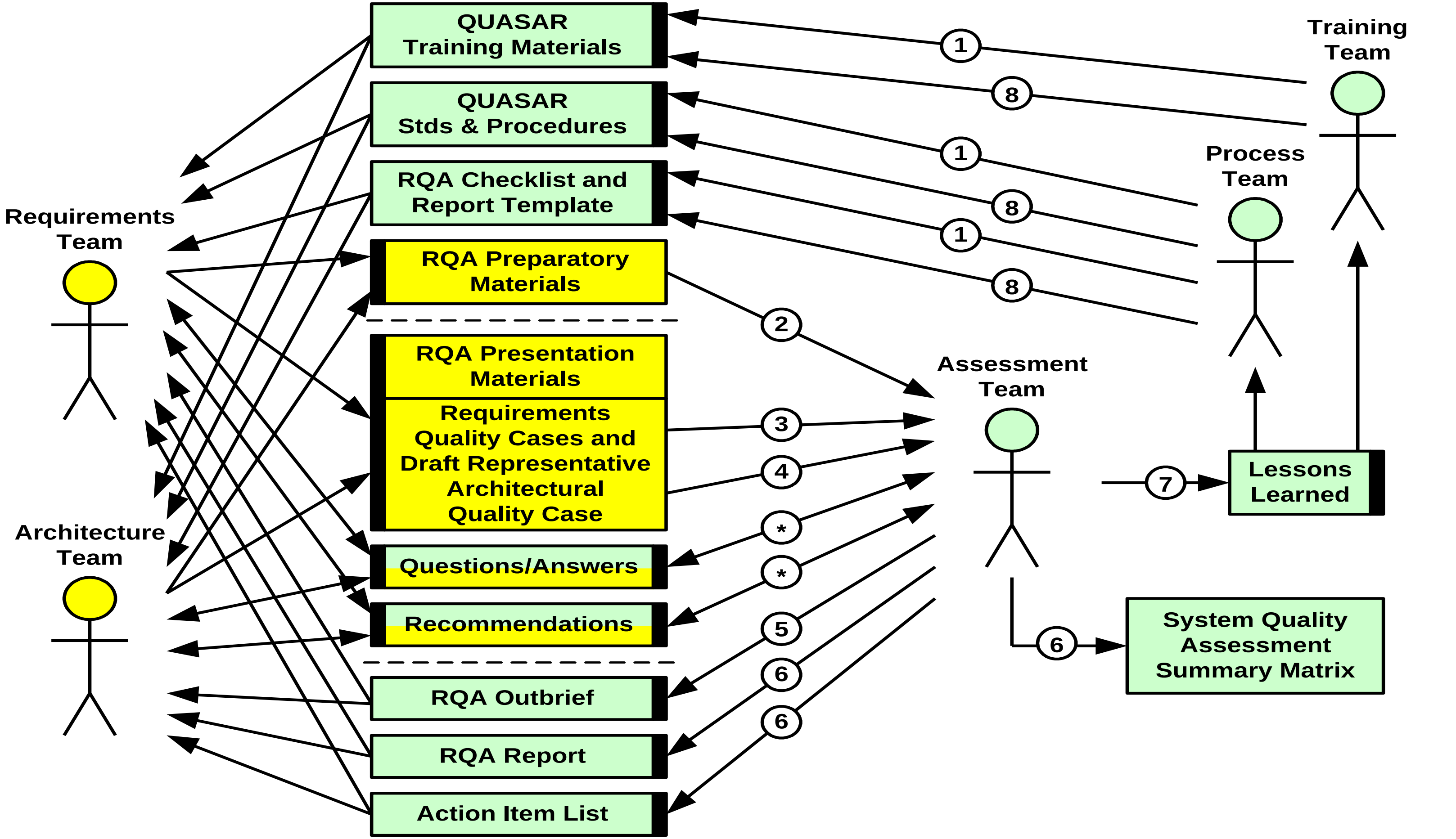
Process Team:

Updates Assessment Method (e.g., Standards and Procedures)

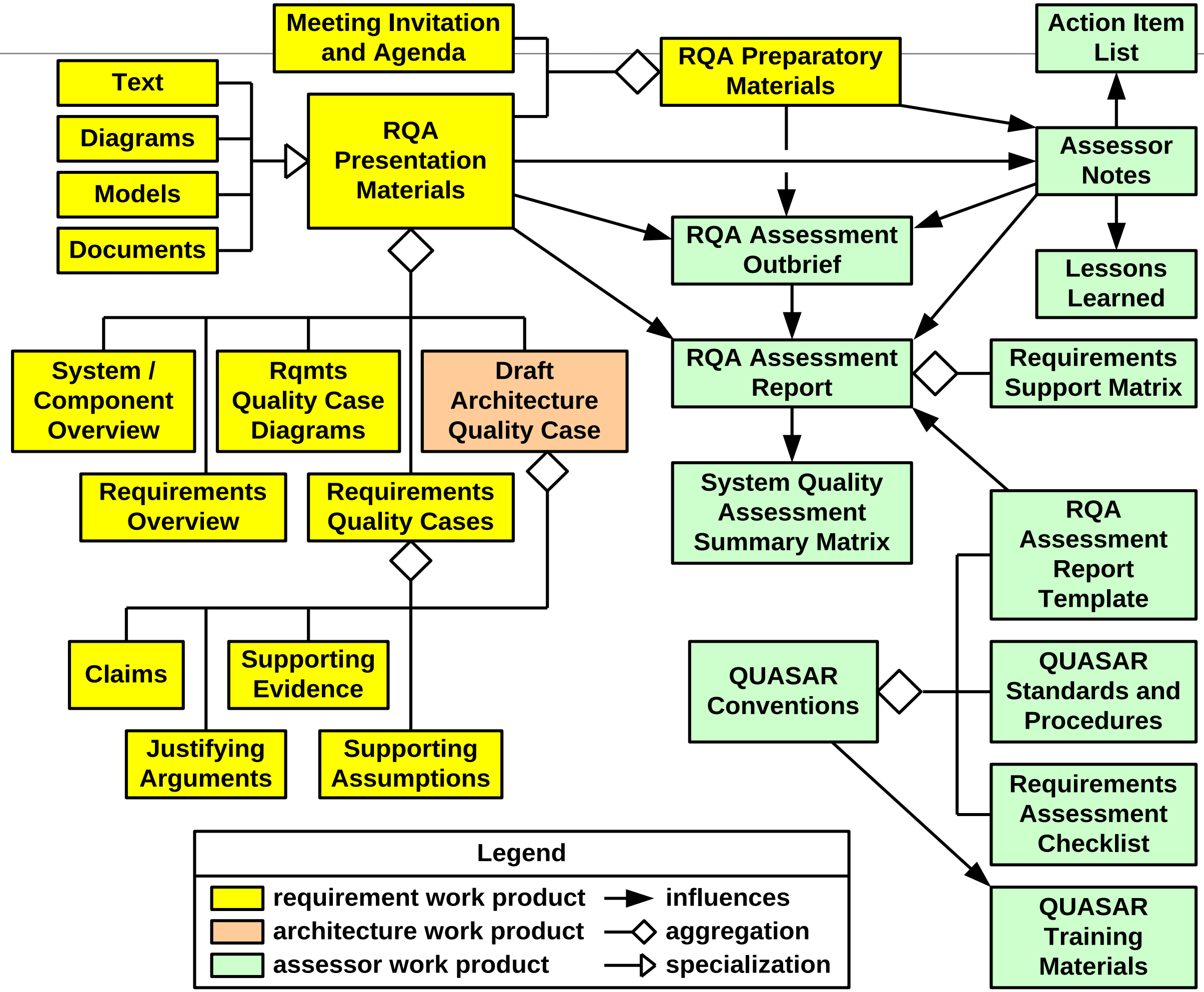
Training Team:

Updates Training Materials (if appropriate)

Phase 2) RQA – Work Product Workflow



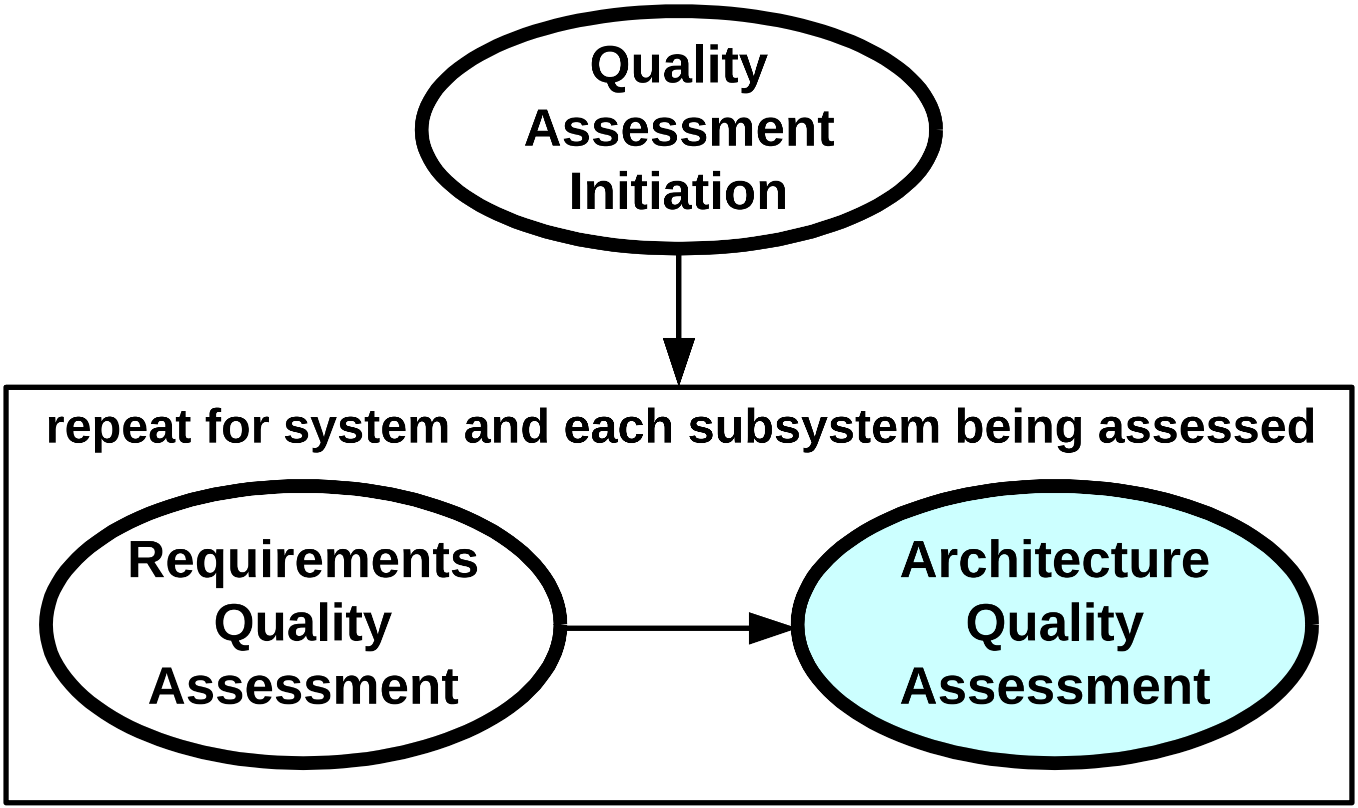
Phase 2) RQA – Work Products



System Quality Assessment Summary Matrix

	SYS		AC 1		AC 2		AC 3		AC 4		AC 5			AC n	
	R	A	R	A	R	A	R	A	R	A	R	A		R	A
QF 1															
QF 2															
QF 3			NA	NA					NA						
QF 4															
QF 5															
QF 6									NA						
QF 7			NA	NA											
QF 8															
QF n															

Architecture Quality Assessment (AQA)



Phase 3) AQA – Objectives

Use Architectural Quality Cases to:

- Independently assess Architecture Quality in terms of its Support for its Derived and Allocated Architecturally Significant Requirements
- Help Architects identify Architectural Defects and Weaknesses so that:
  - Defects and Weaknesses can be Corrected
  - The Architecture (and System) can be Improved
- Identify Architectural Risks so that they can be Managed
- Provide Visibility into the Status and Maturity of the Architecture
- Increase the Probability of Project Success

Phase 3) AQA – Preparation Task

Architecture and Quality Assessment Teams organize the AQA Assessment Meeting.

Training Team provides (at appropriate time):

- QUASAR Training (if not provided prior to RQA assessment)
- AQA Assessment Checklist and Report Template

Architecture Team makes available (min. 2 weeks before meeting):

- Any Updated Quality Requirements
- Architecture Overview
- Quality Case Diagrams
- Architecture Quality Cases (Claims, Arguments, and Evidence)

Quality Assessment Team:

- Reads Preparatory Materials
- Generates RFIs and RFAs

Phase 3) AQA – Meeting Task

Architecture Team:

1. Introduces the Architecture
(e.g., Context and Major Functions)
2. Briefly reviews the Architecturally Significant Requirements
3. Briefly summarizes the Architecture
(e.g., Most Important Architectural Components, Relationships, Decisions, Inventions, Trade-Offs, Assumptions, and Rationales)
4. Individually Presents Architectural Quality Cases
(Quality Case Diagram, Claims, Arguments, and Evidence)

Quality Assessment Team:

1. Probes Architecture (Architectural Quality Case by Quality Case)
2. Manages Action Items

Phase 3) AQA – Follow-Through Task

Quality Assessment Team:

1. Develops Consensus regarding Architecture Quality
2. Produces, reviews, and presents Meeting Outbrief
3. Produces, reviews, and publishes AQA Report
4. Updates and republishes System Quality Assessment Summary Matrix
5. Captures Lessons Learned
6. Manages Action Items

Architecture Team:

Addresses Architectural Defects, Weaknesses, and Risks Raised in AQA Report

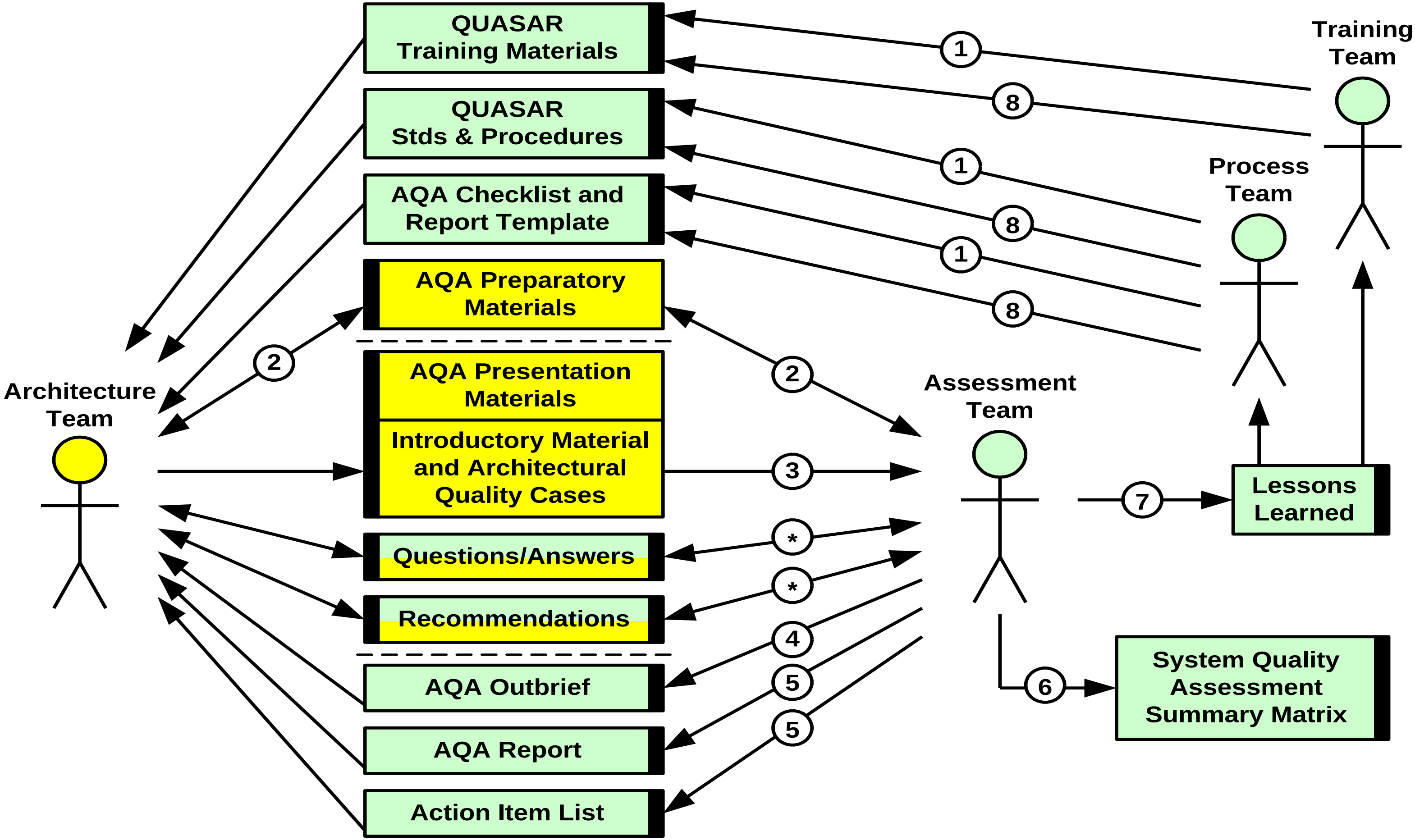
Process Team:

Updates Assessment Method (if appropriate)

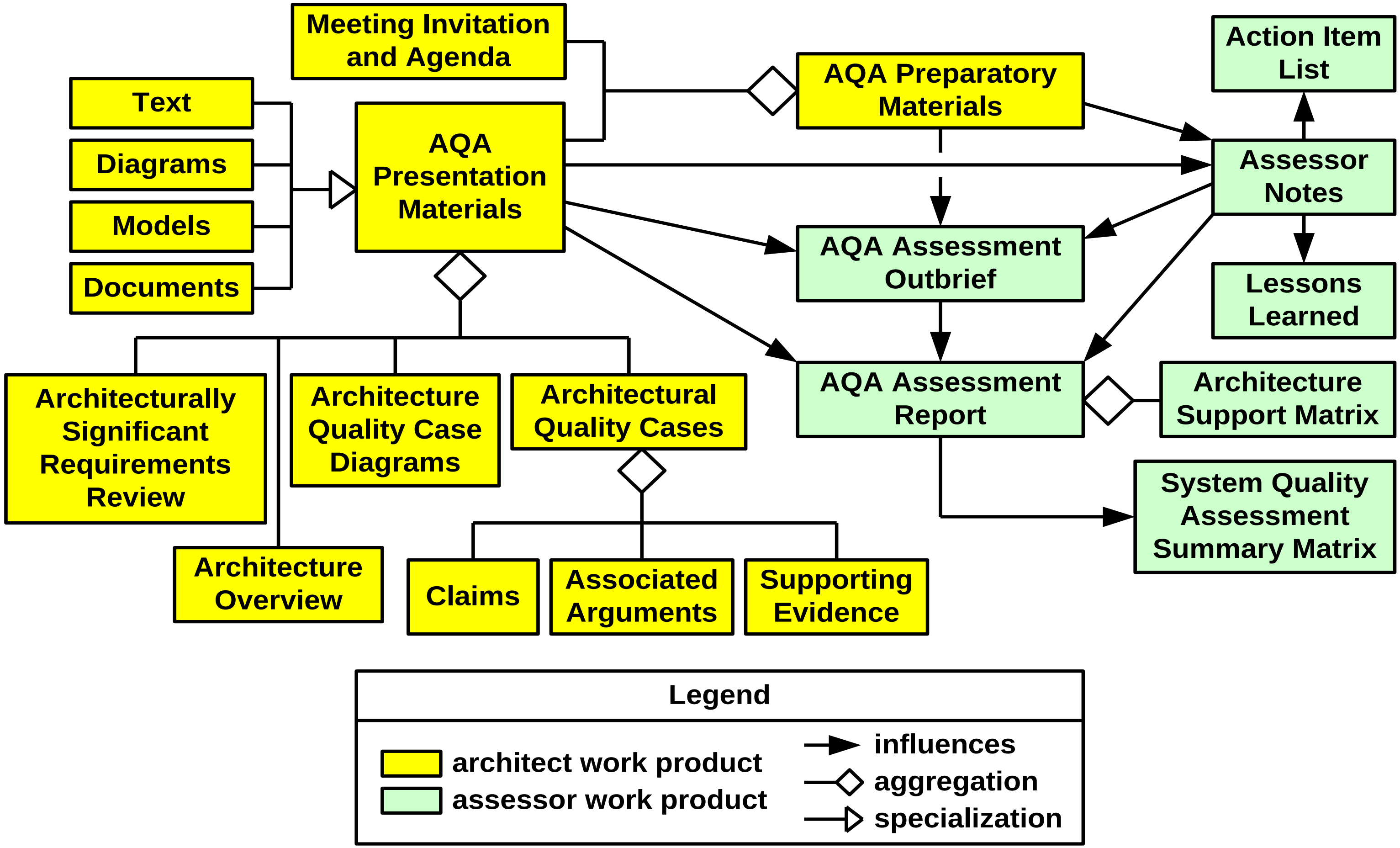
Training Team:

Updates Training Materials (if appropriate)

Phase 3) AQA – Work Product Workflow



Phase 3) AQA – Primary Work Products



Topics

Requirements and Architecture Challenges

Underlying Concepts

QUASAR Method

Reasons to use QUASAR

QUASAR Benefits$_1$

QUASAR ensures Specification of *Architecturally-Significant* Requirements.

QUASAR provides Acquirer Visibility into (and supports oversight of) the Quality of the Requirements and Architecture

QUASAR supports Certification and Accreditation

QUASAR emphasizes using a common project-specific Quality Model:

- Which drives the Quality Requirements
- Which drives the Quality of the System Architecture
- Which drives the Quality of the System

QUASAR Benefits$_2$

QUASAR Supports Process Improvement:

- Solves Major Requirements and Architecture Problems

QUASAR Provides needed Flexibility:

- Any Effective Requirements Engineering and Architecting Methods
- Uses Existing Requirements and Architecture Work Products (i.e., almost no new work products required)
- Any Subsystems based in Need and Risk (i.e., fits any system size, budget, schedule, and tier)
- Any Quality Characteristics and Quality Attributes

QUASAR Helps:

- *Requirements Engineers* Succeed
- *Architects* Succeed
- *Program* Succeed

How the SEI Can Help You

QUASAR is Ready for Use *Now*.

QUASAR Handbook and Training Materials can be downloaded from SEI Website.

The SEI Acquisition Support Program (ASP) offers QUASAR as a Service:

- Consulting and Training
- Facilitation of QUASAR Assessments
- Recommended RFP and Contract Language

Questions?

For more information:

Donald Firesmith

Acquisition Support Program

Software Engineering Institute

dgf@sei.cmu.edu

The Method Framework for Engineering System Architectures (MFESA), Donald Firesmith et al., Auerbach Publishing, November 2008

Quasar Tutorial (1 day) : http://www.sei.cmu.edu/library/abstracts/presentations/quasartutorial2008.cfm

Models & Simulations Development Best Practices

NDIA Systems Engineering Conference

29 October 2009

•Katherine L. Morse, PhD
•Robert Lutz
•Shon Vick
•Nathaniel Horner

The Johns Hopkins University
APPLIED PHYSICS LABORATORY

Presentation Outline

- Background
- Study Objectives and Major Technical Activities
- Survey and Literature Search
- Best Practice Template and Example
- Simulation Interoperability Standards Organization (SISO) Study Group
- Systems Engineering Framework
  - Literature Search Results
  - Current Status
- Integration Plan and Evaluation Criteria
- Best Practices Review Status
- Planned Next Steps
- Discussion

Background

- Although the importance and use of modeling and simulation tools (models, simulations, and utilities) is expanding across the DoD, relatively few persons have a good grasp of the process and principles that should be followed when developing such tools.
  - The DoD has identified the Federation Development and Execution Process (FEDEP - IEEE 1516.3) as a recommended practice for distributed simulation federations using the HLA, but no equivalent best practice exists for the development of individual modeling and simulation tools.
- Whether conducting such a development or overseeing a contractor's efforts to do so, DoD acquisition professionals need to understand best practices for developing modeling and simulation tools.

Study Objectives and Major Technical Activities

- Study Objectives
  - Identify effective practices for the efficient development and evolution of credible models and simulations
- Major Technical Activities
  - Conduct a literature search and survey of M&S tool developers to identify sound practices for M&S development
  - Develop an overarching systems engineering framework for describing the activities and tasks necessary for effective M&S development
  - Develop a plan for populating the SE framework with the appropriate process elements (activities and tasks), and for capturing best practices specific to chosen domain areas
  - Review the draft framework with organizations and individuals that can help ensure its correctness and appropriateness
  - Refine the core process document descriptions per the above reviews

Literature Search

- Assembled bibliography of (mostly) journal and book sources
- Searched NDIA, Simulation Interoperability Workshop (SIW) and Interservice/Industry Training, Simulation & Education Conference (I/ITSEC) papers from the last 5 years
- Literature search and survey together resulted in approximately 116 practices for consideration

Initial Community Survey

1. Does your organization develop models/simulations, supporting environments for developing models/simulations, or both?
2. Are your organization's practices based on industry standards or internally developed? [Industry standards – skip to Question 4]
3. Is your organization willing to provide a detailed description of these practices to the JHU/APL Study Team, assuming any intellectual property is properly protected by a non-disclosure agreement? [Internally-developed practices stop here]
4. Please name and provide appropriate references for the industry standards upon which your practices are based.
5. Please describe your tailoring of the industry standards for application within the M&S domain. If you would prefer to discuss this with the study team under a non-disclosure agreement (NDA) to protect your intellectual property, please so indicate.

Initial Survey Results

- 47 respondents
- 4 have proprietary practices they won't discuss without NDA
- Respondents were almost evenly split between using industry standards and internally developed practices
- Most respondents develop both models/simulations and supporting environments
- There was some confusion on the question about industry standards used because several responded with HLA and Distributed Interactive Simulation (DIS)
  - This confusion will be cleared up in the follow-on conversations
  - Fewer than half of respondents answered this question at all
  - CMMI – 7; ISO 9000/9001 - 5 (8?); INCOSE – 1; EIA-632 - 1

Best Practice Template with Example

ID #	Short Descriptive Title
3	Consistent intermediate conceptual model
SE Framework Category	POC: Name, Email Address, Phone #; "literature" for literature search
Requirements engineering, system design, technical overlays	literature
Description	
A well-conceived, consistent intermediate [conceptual] model eliminates many problems by providing a representation of the battlespace usable by all participants (customer, domain expert, developer, and user). Knowledge objects enable the certification of information pedigree; can track changes in information; provide corrective updates when necessary	
Rationale (Why the practice is useful/needed.)	
A major challenge [to developing M&S to support SE] is creating computationally amenable descriptions of the infinitely rich world with which the software development team can work. There [is] a disconnect between the knowledge management and SE processes.	
Source Reference: If derived from an industry standard, provide document name and version, and section number(s)	
Proceedings of the 9th NDIA Systems Engineering Conference, "'Training for Models: The Role of Knowledge Management in Applying Modeling and Simulation (M&S) to Systems Engineering," David R. Pratt and Robert W. Franceschini	
Notes	
The paper was about a proprietary process, but the use of an intermediate conceptual model is broadly applicable.	
If this practice is derived from another source, complete the sections below.	
Rationale for Tailoring	
Description of Tailoring for M&S	

SISO Study Group

- Formed to provide input and feedback to study
  - Potential source of additional information
  - Tasks and deliverables are limited to review and recommendations
- Is a necessary first step in the SISO process if we want the results of the study to form the basis of a SISO standard
- Kickoff meeting at the Spring SIW
  - March 25, 2009
  - San Diego, CA

Systems Engineering Framework Literature Search Results

- International Council on Systems Engineering (INCOSE) Handbook (v3.1)
- Electronic Industries Alliance (EIA) Processes for Engineering a System (EIA-632)
- Institute for Electrical and Electronics Engineers (IEEE) Standard for Application and Management of the Systems Engineering Process (IEEE-1220)
- International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC) Systems engineering - System life cycle processes (ISO/IEC-15288)
- Military Standard - System Engineering Management (MIL-STD-499C)
- IEEE Federation Development and Execution Process (FEDEP) (IEEE 1516.3-2003)/Distributed Simulation Engineering and Execution Process (DSEEP) (IEEE P1730)
- Capability Maturity Model Integration (CMMI)

SE Framework Outline

- **Phase 1: *Requirements Development***
  - Activity 1: *Develop Stakeholder Requirements*
  - Activity 2: *Develop and Analyze System Requirements*
  - Activity 3: *Validate Requirements*
- **Phase 2: *Conceptual Analysis***
  - Activity 1: *Develop Conceptual Model*
  - Activity 2: *Validate Conceptual Model*
- **Phase 3: *Product Design***
  - Activity 1: *Perform Functional Analysis*
  - Activity 2: *Synthesize Design*
  - Activity 3: *Verify Design*
- **Phase 4: *Product Development***
  - Activity 1: *Establish Software Development Environment*
  - Activity 2: *Implement Product Design*
- **Phase 5: *Product Testing***
  - Activity 1: *Perform Product Verification*
  - Activity 2: *Perform Product Validation*
- ***Project Management Practices***
  - *Project Planning*
  - *Project Control/Resource Management*
  - *Risk Management*
  - *Quality Management*
  - *Configuration Management*

Integrating Best Practices into the SE Framework

1. While identifying and documenting sound practices, the study team is tagging them according to our SE framework categories and activities
2. The team has developed a set of evaluation criteria (next 3 slides) for selecting best practices from the sound practices
3. Once the best practices are identified, the study team will review the practices in each category, shifting them to other categories as necessary, and resolve any conflicts/overlaps between closely related best practices, probably merging conflicts/overlaps into a single practice
4. The final set of best practices will be assigned by consensus of the study team into the individual activities of each SE category
   - And, of course, the contributors and community will review this assignment

Criteria (1 of 3)

- **Specificity – Does the practice have demonstrated effectiveness within specific M&S domains?**
- **Comparability – Has the practice been compared positively to other practices in controlled studies (or could it be)?**
- **Degree of Independence – Is the practice platform or implementation independent?**
- **Efficacy – Does the practice support effective use of resources including intellectual capital?**
- **Customization – Does the practice allow customization and tailoring to an organization or domain's needs?**
- **Coherence – Does the practice align with other adopted best practices?**
- **Robustness - Does the practice usually result in a better outcome?**

Criteria (2 of 3)

- Cohesion - Does the practice describe a single idea, concept or construct and not multiple ones grouped into a single practice?
- Coupling - Is the practice's adoption independent of other practices, i.e. does the adoption of this practice necessitate the adoption of another?
- Sustainability – Is it cost effective to sustain the practice after adoption?
- Usability – Can the practice be used, learned and employed in practice?
- Scalability – Is the practice scalable to projects of different sizes?
- Agility – Can the practice adapt to changing conditions, e.g. organization changes, contextual changes, etc.) readily?
- Generality – Is the practice expressed as generally as possible?
- Legal aspects – Is adoption of the practice free of difficult legal/proprietary aspects?

Criteria (3 of 3)

- **Consensus – Is there widespread community acceptance of the practice?**
- **Cost Elasticity – Do the benefits of the results outweigh the cost of adoption of the practice?**
- **Repeatability – Does the practice repeatedly give desired results?**
- **Durability – Does the practice remain effective over time?**
- **Applicability – Is the technology related to the practice widely applicable and not just to a subset of problems or domains?**

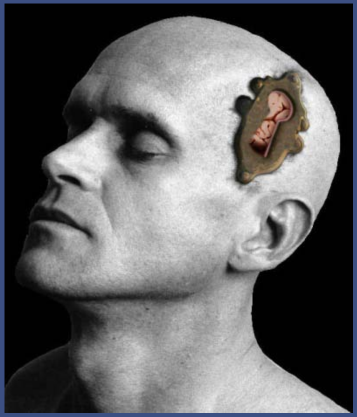
Best Practices Review Status

- Started with 116
- Removed those that restated concepts already in the SE Framework
  - Approximately 10
- Team members individually:
  - Assessed practices against evaluation criteria
  - Assigned practices to phases and activities in the SE Framework
  - Assessed whether the practices were M&S specific
- Team is working through practices in batches, debating our positions and reaching consensus
  - Approximately half complete and making good progress
- Identified the need to clean up several practices
  - Transcription errors
  - Overlaps between practices
  - Separating rationale from practice

Planned Next Steps

- Complete SE framework
- Complete review and clean-up of practices
- Integrate practices into framework
- Get feedback from stakeholders and contributors on framework and best practices

Questions?



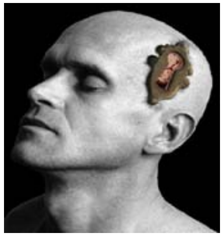
Achieving Acquisition Excellence via Improving the Systems-Engineering Workforce

Dr. Kenneth E. Nidiffer
Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213

October 29, 2009

12th Annual NDIA
Systems Engineering Conference
“Achieving Acquisition Excellence via Effective Systems Engineering”
San Diego, CA
26-29 October

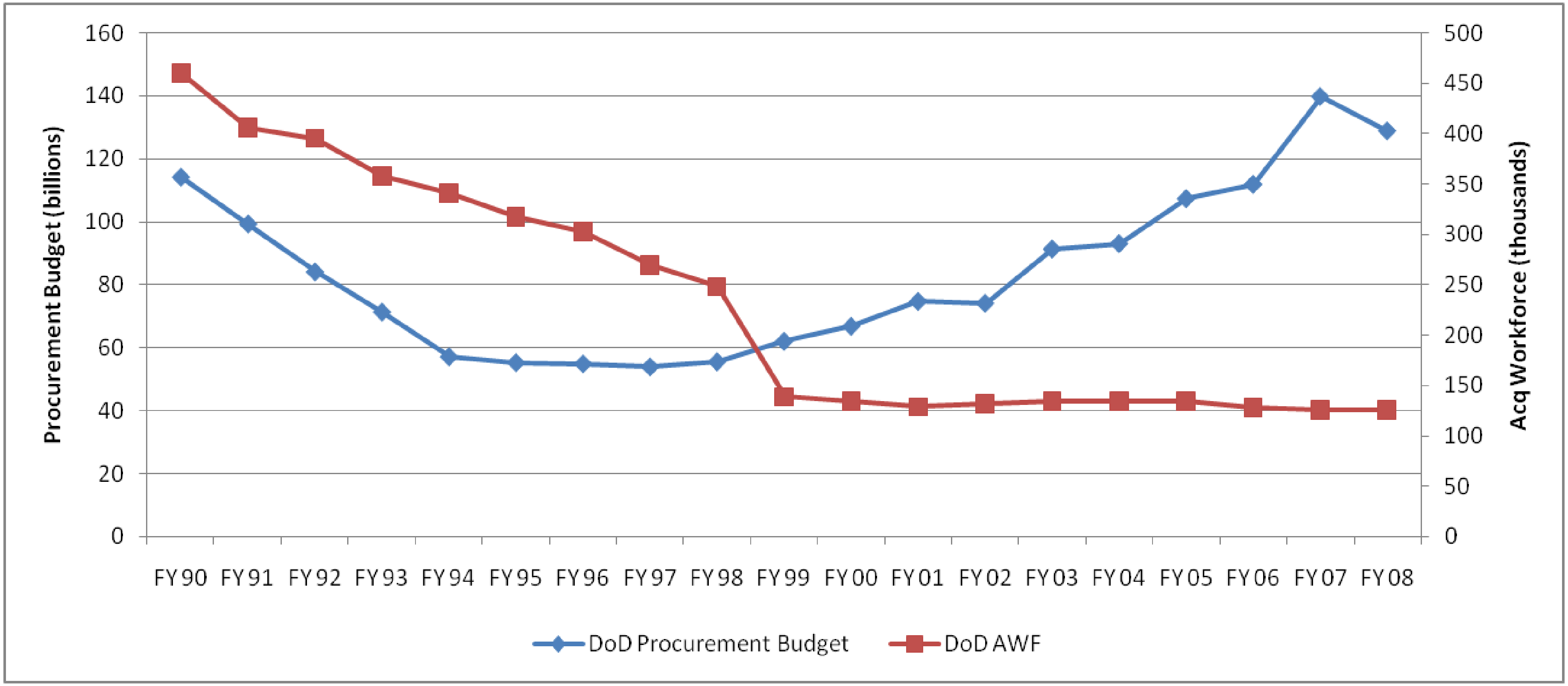
Overview



- Is your organization working towards achieving acquisition excellence?
  - The application of systems-engineering to improve the workforce may be part of the answer!
- What are the rate-limiting variables/drivers that limit success?
- How can the CMMI ® - ACQ model be used?

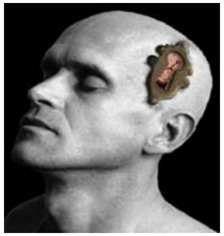
Achieving Acquisition Excellence via Effective Application of CMMI ® -ACQ

Procurement Budget vs. DoD Acquisition Workforce



Increasing # of Procurements & Complex Systems Coupled With Huge Decrease In Acquisition Workforce

Recapture Acquisition Excellence: Revitalize The Acquisition Workforce



Problem

- **Acquisition capability has slowly atrophied**
- **Organic Workforce reductions - 23% since 1999**
  - **Force shaping, reduced training, retirements of critical cost estimators, price analysts, experienced system engineers, contracting officers**

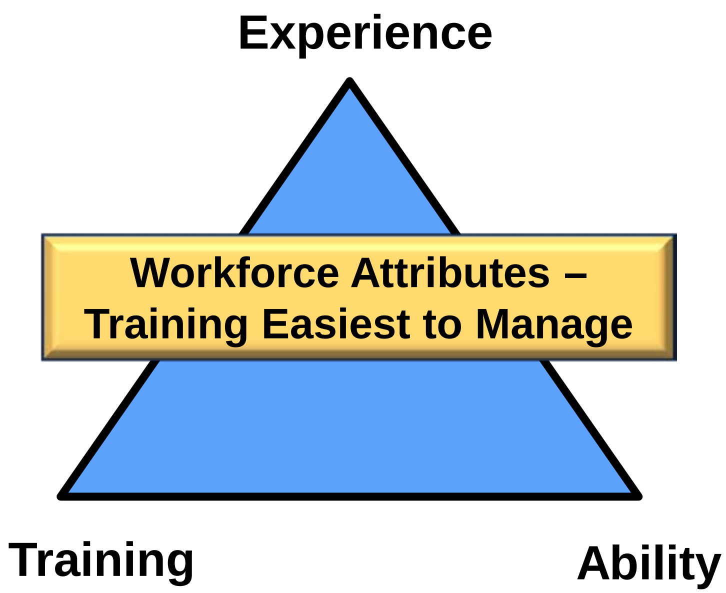
Initiatives

- **Recapitalize the Acquisition Corps/Training**
- **OSD Funding Increased Numbers and Training of Organic Acquisition Personnel**

It Is All About the Acquisition Workforce

Project Purpose

Use a systems engineering approach to assess acquisition training and organizational training processes for improving acquisition excellence



Summary of Systems Engineering Drivers

External Forces

- Increasing size of untrained defense acquisition workforce
- Retiring of experienced and capable workforce

Technological

- Accelerating technological changes makes systems specific acquisition training difficult at best
- Identifying future competencies to ensure most relevant training content

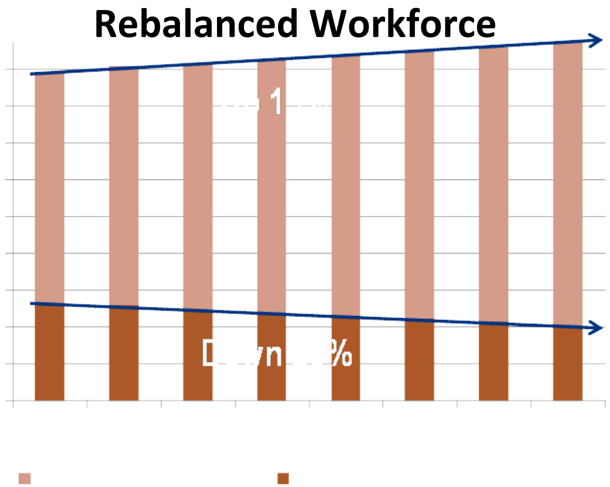
Human Capital

- Changing workforce demographics requiring newer methods of training and management

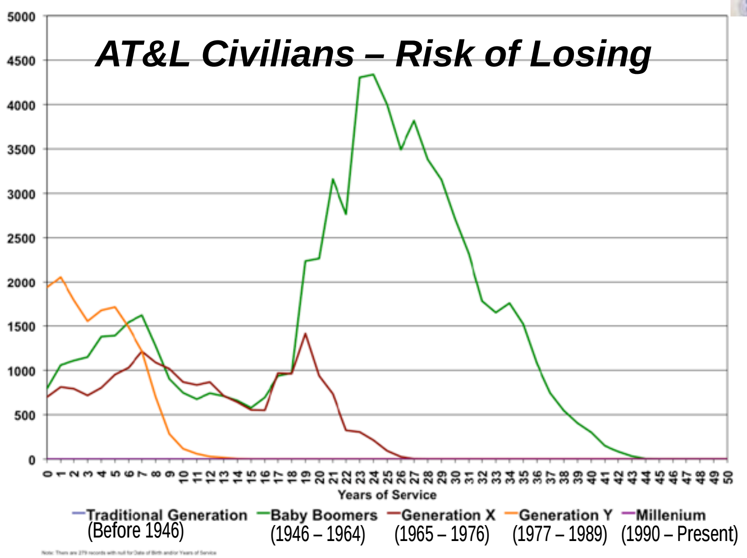
Client Business Environment

- Achieving acquisition excellence in a fiscally constrained environment

External Forces

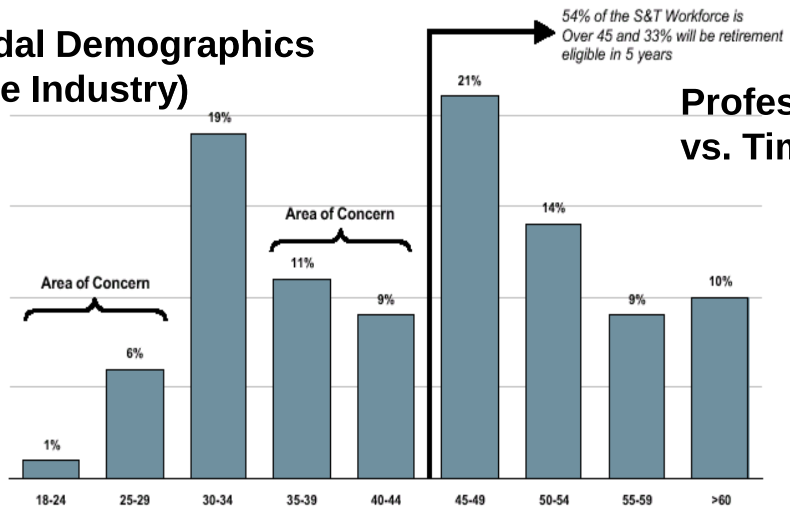


Source: DAU



Source: DAU

Bimodal Demographics (Space Industry)

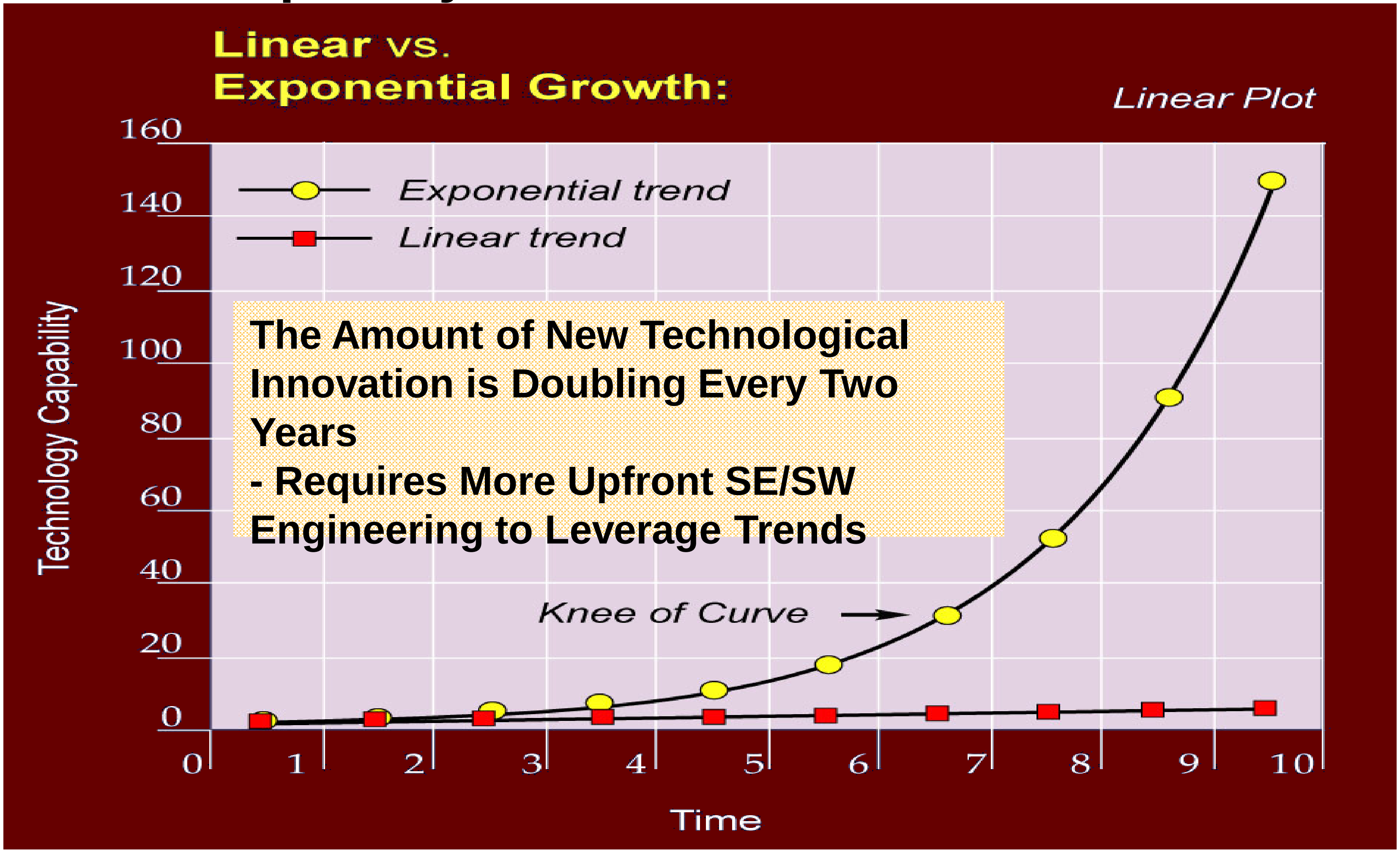


Source: LMSC

Professional Growth vs. Time

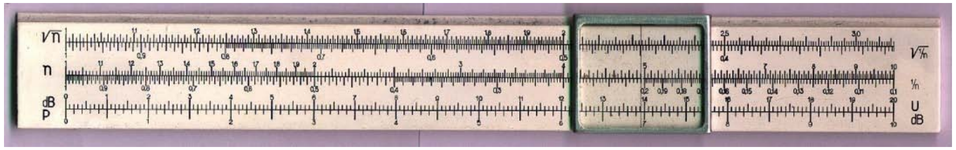
Source: DAU

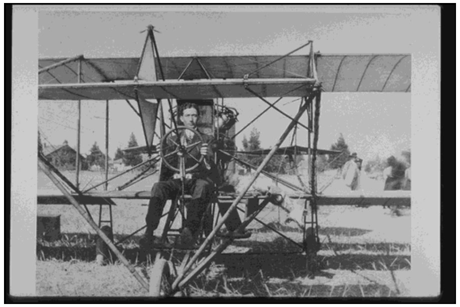
Technological: Acceleration of Innovation in the 21st Century - Facilitating Our Ability to Build Move Complex Systems



Technological: Augustine's Law Holding - Growth of Software is an Order of Magnitude Every 10 Years

In The Beginning





1960's

F-4A
1000
LOC

1970's

F-15A
50,000
LOC

1980's

F-16C
300K
LOC

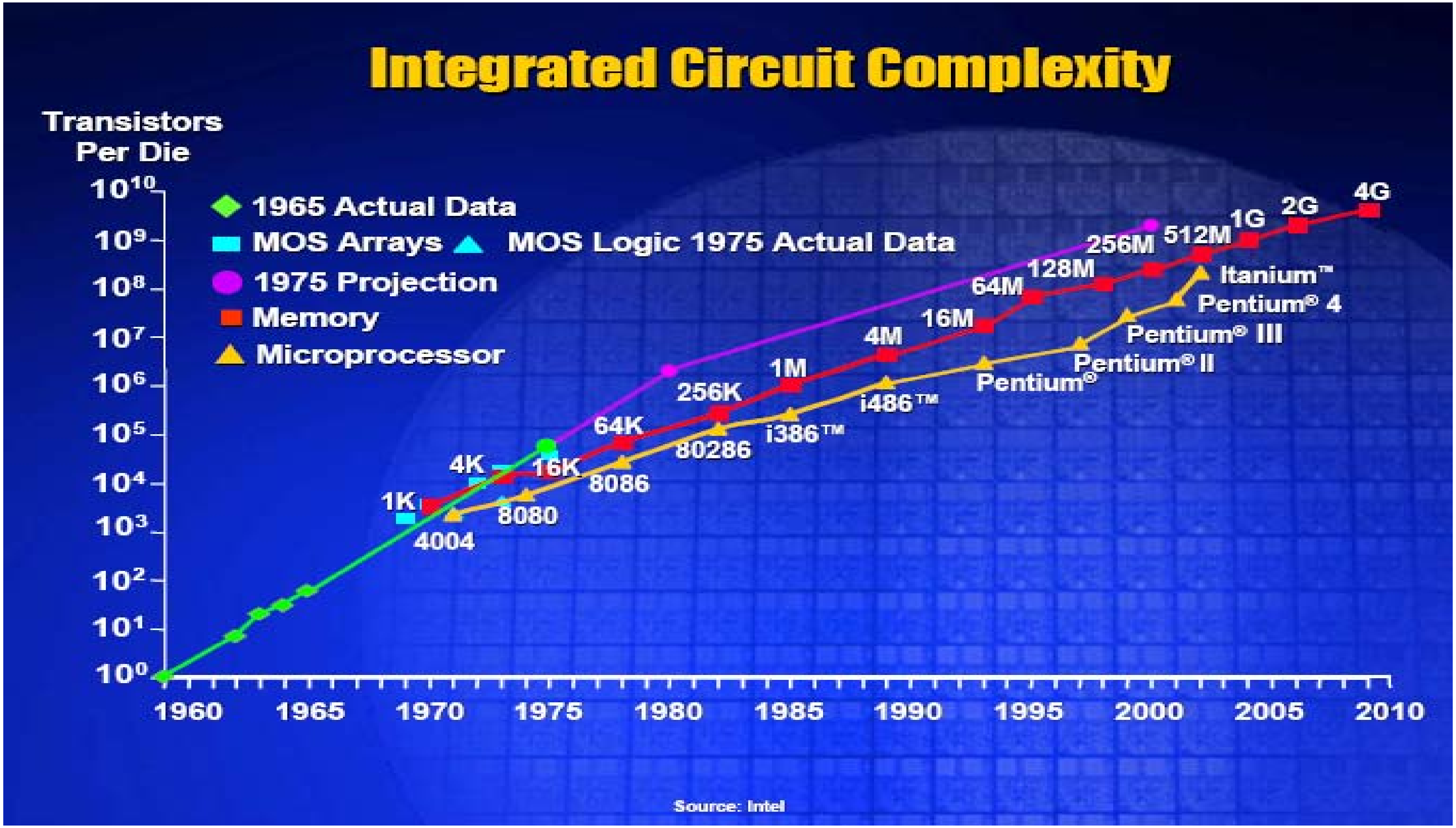
1990's

F-22
1.7M
LOC

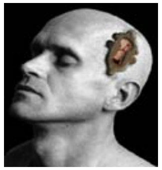
2000+

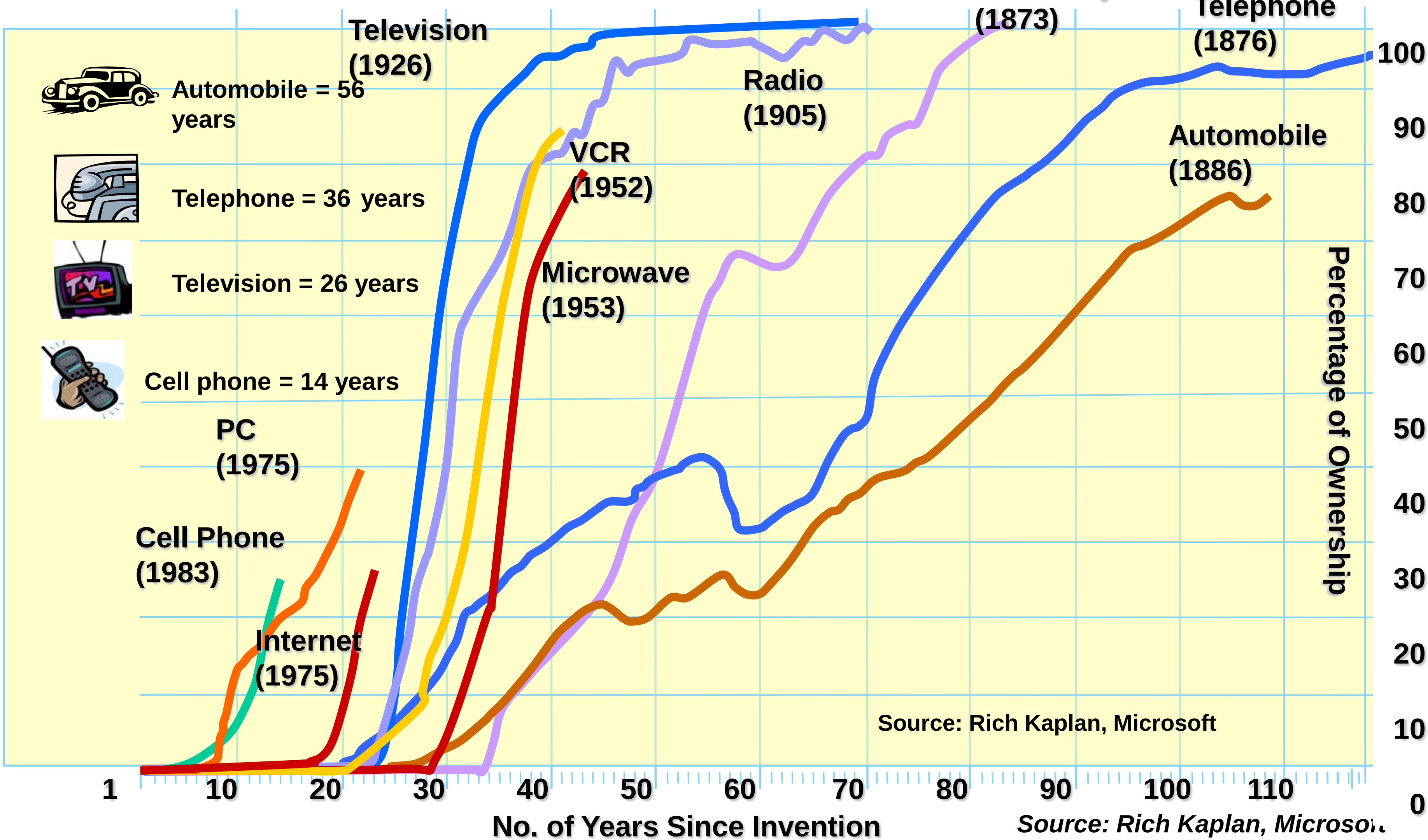
F-35
>6M
LOC

Technological: Moore's Law Holding - The Number of Transistors That Can be Placed on an Integrated Circuit is Doubling Approximately Every Two Years

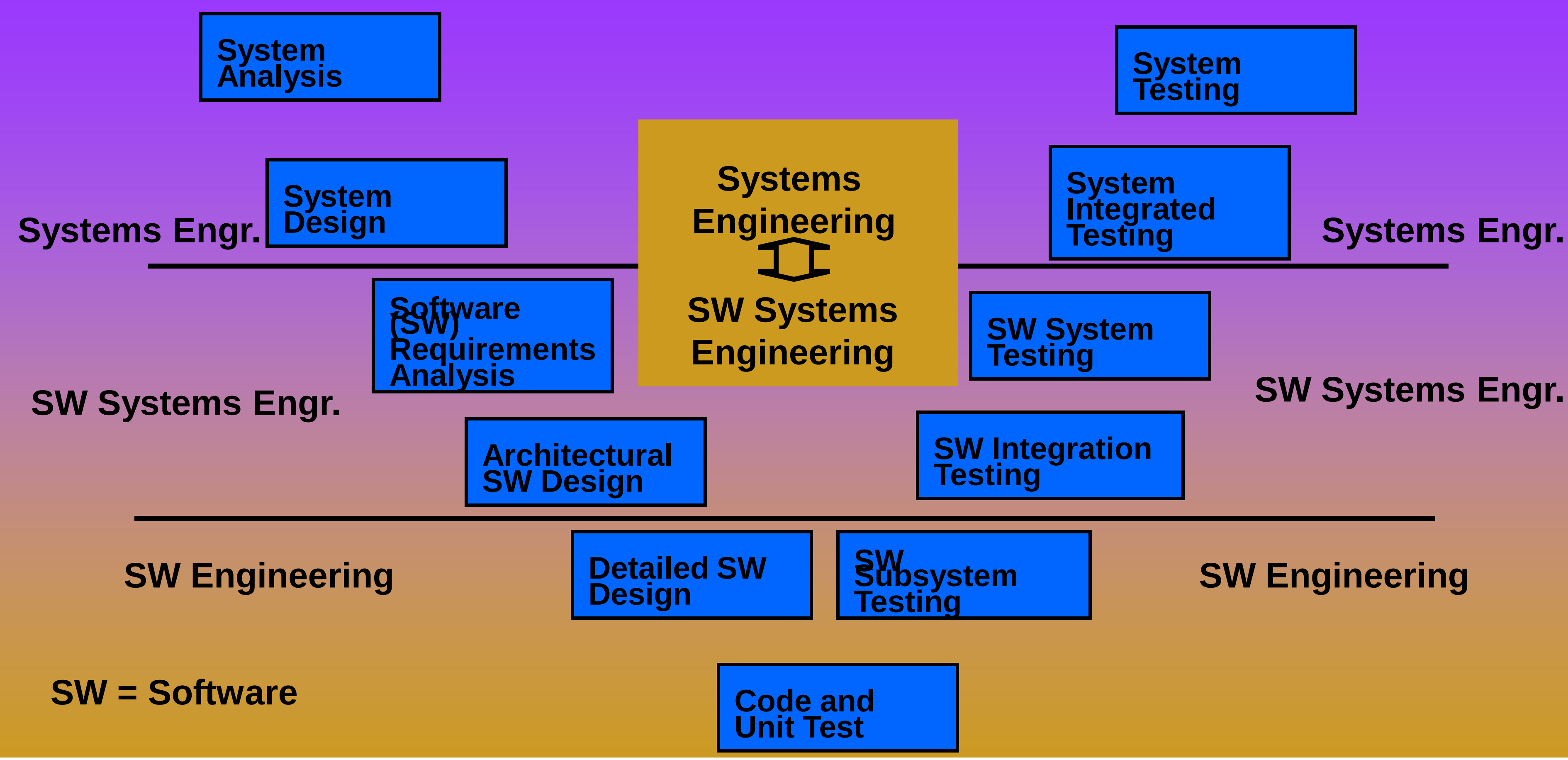


Technological: Increasing Rate of Adoption





Human Capital: Refocusing University Curriculums - Alignment of Software Systems Engineering



OSD Initiatives: Graduate Software Engineering Reference Curriculum (GSwERC) & Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE)

Human Capital: Using Core Competencies

- Accurate identification of required competencies are important to support the curriculum review and development effort needed to ensure the best and most relevant training.

Software Engineer IV

Software Engineer III

Software Engineer II

Software Engineer I

Knowledge	Application domain Procedural design Cobol & Assembler Numerical analysis
Skills	Requirements analysis System design Project management Debugging
Process Abilities	Integrated team design Fagan inspections Test procedures Change control

Competency Family
Software Engineering

Current Resource Profile (initial inventory)

Workforce Competency	Staffing by Capacity Level			
	I	II	III	IV
Software Engineer	17	25	12	5
User Training	2	8	4	1

Current Resource Needs (one-year cycle)

Workforce Competency	Current Staffing Level Needed			
	I	II	III	IV
Software Engineer	23	30	15	7
User Training	4	9	6	2

Strategic Workforce Needs (2-5 year)

Workforce Competency	2010Staffing Level Needed			
	I	II	III	IV
Software Engineer	31	35	18	9
User Training	4	10	8	3

Human Capital: Changing Demographics

Demographics of workforce are changing and different views may emerge with four generations to consider

Generation Y professionals entering workforce will likely necessitate non-traditional training techniques, such as virtual approaches

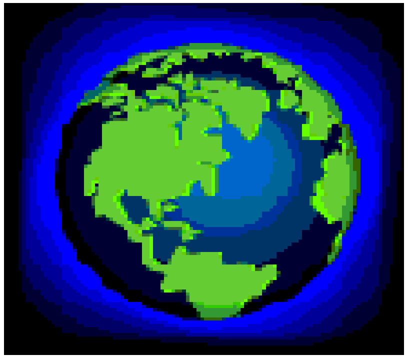
Silent Generation 1928-1945	Baby Boomers 1946-1964	Generation X 1965-1980	Generation Y/Millenials 1981-2000
Hard worker	Workaholic	Technically advanced	Technically savvy
Respects authority	Questions authority	Prefers informality	Embraces diversity
Work is obligation	Works efficiently	Needs structure and direction	Requires supervision
Formal communicator	Competitive	Direct/immediate communicator	Indirect/virtual communicator
Work/family separation	Little work/life balance	Seeks work/life balance	Demands work/life balance

Client Business Environment: Increasingly Complex

Characteristics	Commercial Software Products	Information Technology & Internet Financial Services	Government Aerospace Systems
Market	Commercial	Information technology & internet	Government
Industry	Software	Financial	Aerospace
Packaging	Products	Services	Systems
Primary Output	Software	Integrated system engr & HW & SW & network	Integrated system engr & HW & SW & network
Purpose	User empowerment: effectiveness, efficiency, creativity	Organization/business operations	Mission/science capabilities
Project Duration	1-36 months	1-18 months	6 months - 10 years
Team Size	1-1000's	1-1000's	10's-1000's
Ratio of Custom to COTS/Reuse	Software: Low-high	Business logic: High Others: Low	All: High
Agreement	License	Service level agreement	Contract
Customer	External	Internal and external	External
# Customers	100's-1,000,000's	1-1,000,000's	1
Focus	Features, Time-to-market, Ship it	User experience, Workflow cycletime, Uptime	Reliability, Milestones, Interdependencies

Source – Northrop Grumman

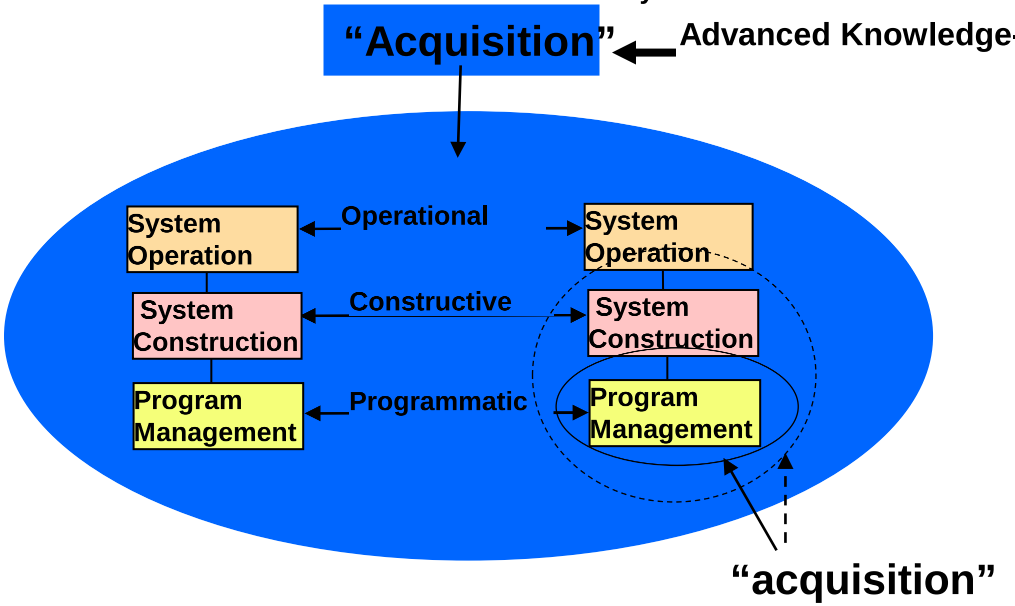
Client Business Environment: Acquisition Shifts



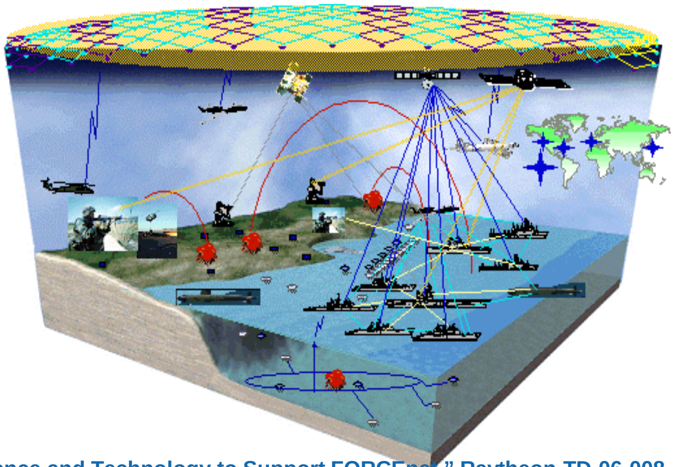
2005 study confirmed*:

- In advanced knowledge-based organizations, management's desire for the flow of knowledge is greater than the desire to control boundaries
- Unlike the matrix organization, there is less impact on the dynamics of formal power and control

* Using Communities of Practice to Drive Organizational Performance and Innovation, 2005, APQ study



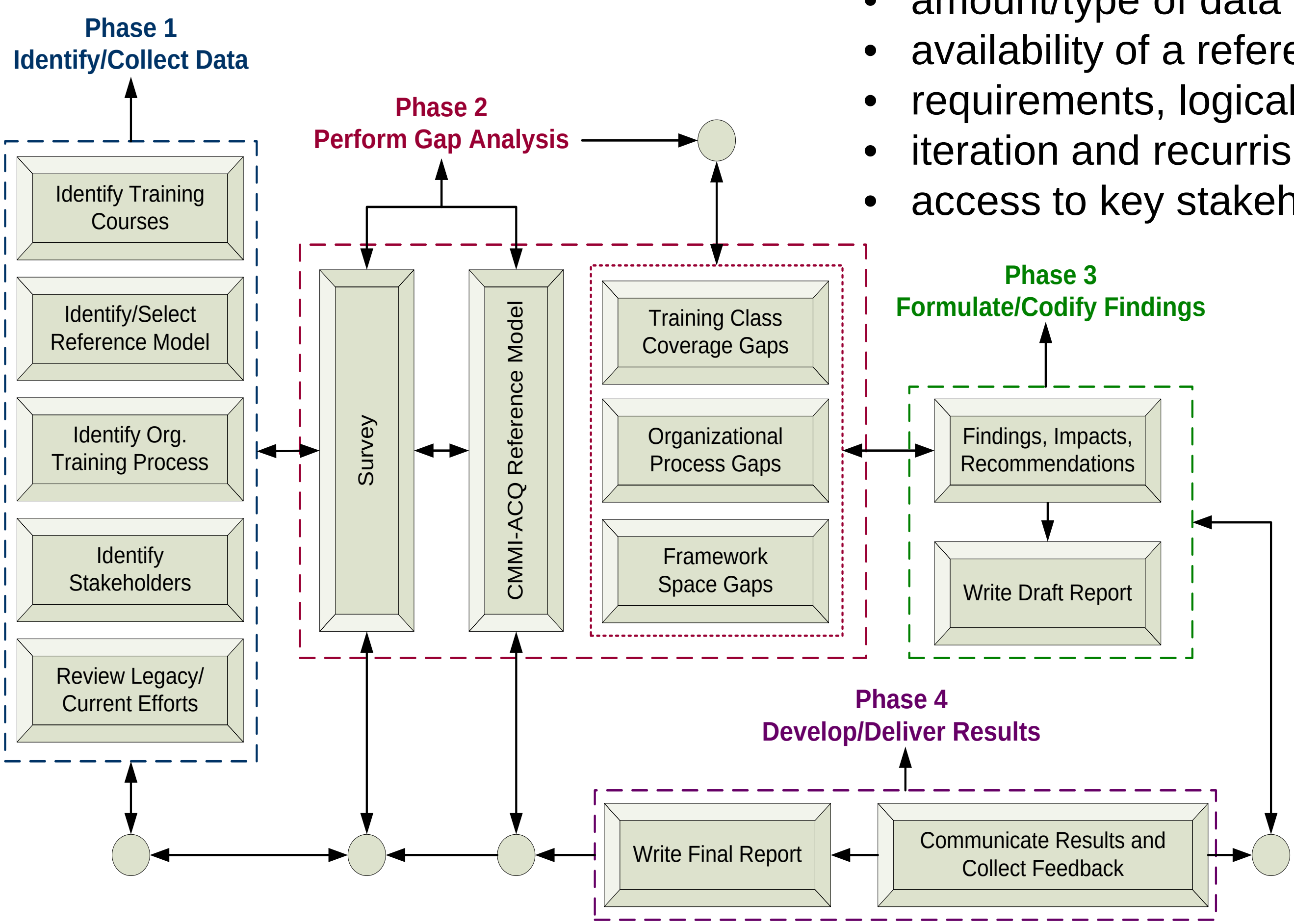
Advanced Knowledge-Based Organizations (Big A)



From "Science and Technology to Support FORCEnet," Raytheon TD-06-008. Used by permission.

Ref: Jim Smith, (703) 908-8221,jds@sei.cmu.edu

Systems Engineering Approach



Selected based on

- amount/type of data to be reviewed
- availability of a reference model
- requirements, logical and physical loops
- iteration and recurrision activities
- access to key stakeholders

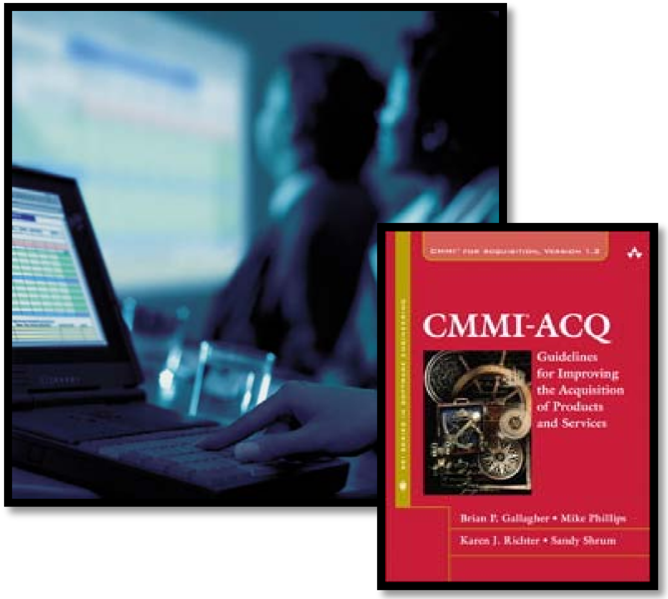
Project Objectives

During assessment Phase 1 project objectives were formulated in terms of five questions

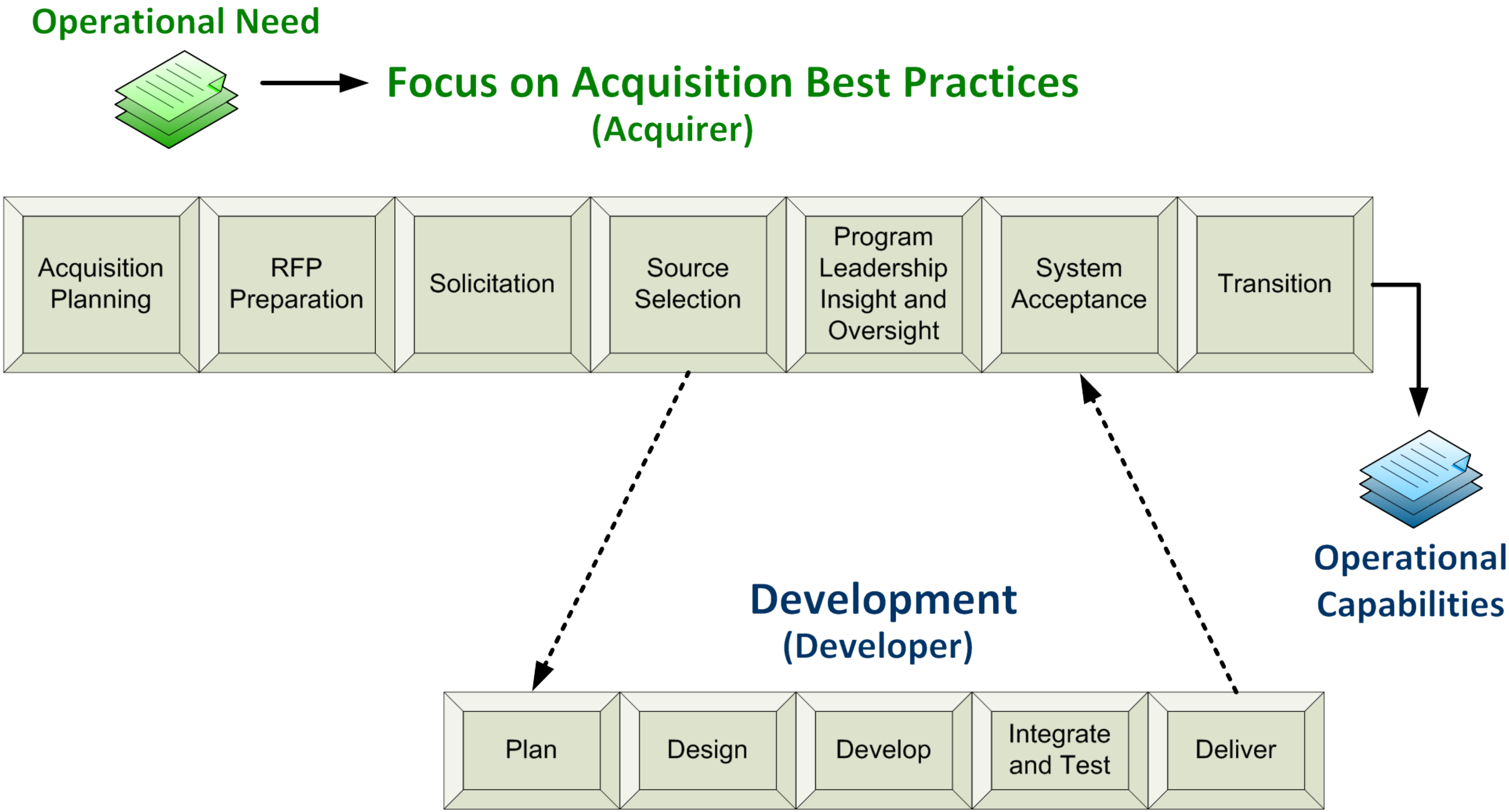
- Do coverage gaps exist in the training of acquisition best practices?
- Do gaps exist in acquisition training on the unique aspects of the client's system acquisitions?
- Do gaps exist in the training of the client's acquisition lifecycle framework and processes?
- Do best-practice gaps exist in the client's organizational training processes?
- Do gaps exist in identifying training requirements for satisfying the acquisition workforce core competencies?

Reference Model

Evaluated client’s acquisition training program components using Capability Maturity Model Integration® for Acquisition (CMMI® -ACQ) as reference model



Assessment Framework: *CMMI®-ACQ*



Representative Results: *Question 1*

Question 1: Do Coverage Gaps Exist in the Training of Acquisition Best Practices?

Findings:

- **Detailed findings awaiting client approval**

Impacts:

- Missing opportunities to
  - ~ attract more students
  - ~ provide training on the most relevant issues
  - ~ effectively plan
  - ~ save resources
  - ~ provide a richer variety of courses
  - ~ continuously improve training processes

Recommendations:

- Conducting a review to assess use of web-based and non-traditional acquisition training

Considerations:

Consider: Leveraging of efforts by DAU, commercial industry and academia

- Conducting a review of best practices for e-learning

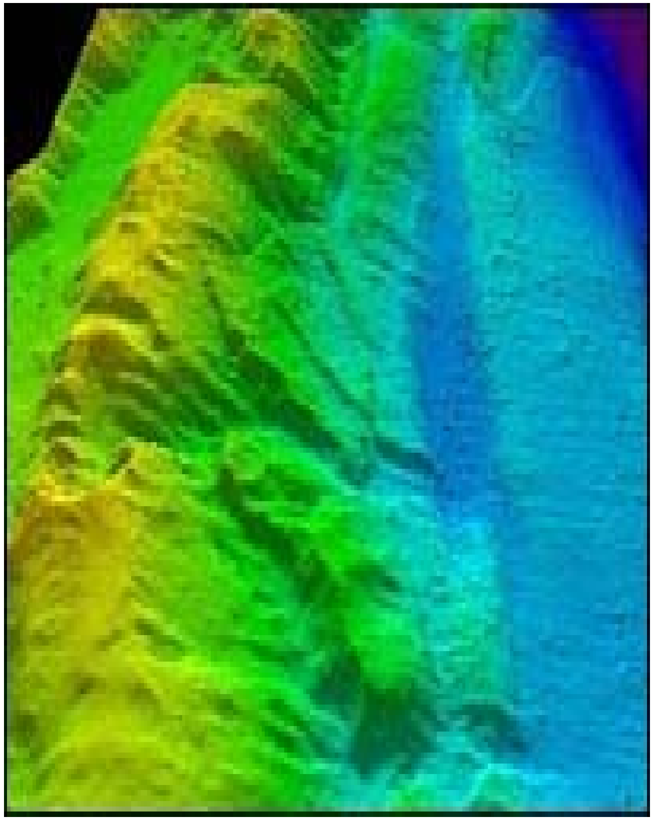
Consider: *Using* DAU's Acquisition Best Practices

- Making a better use of repository information

Lessons Learned

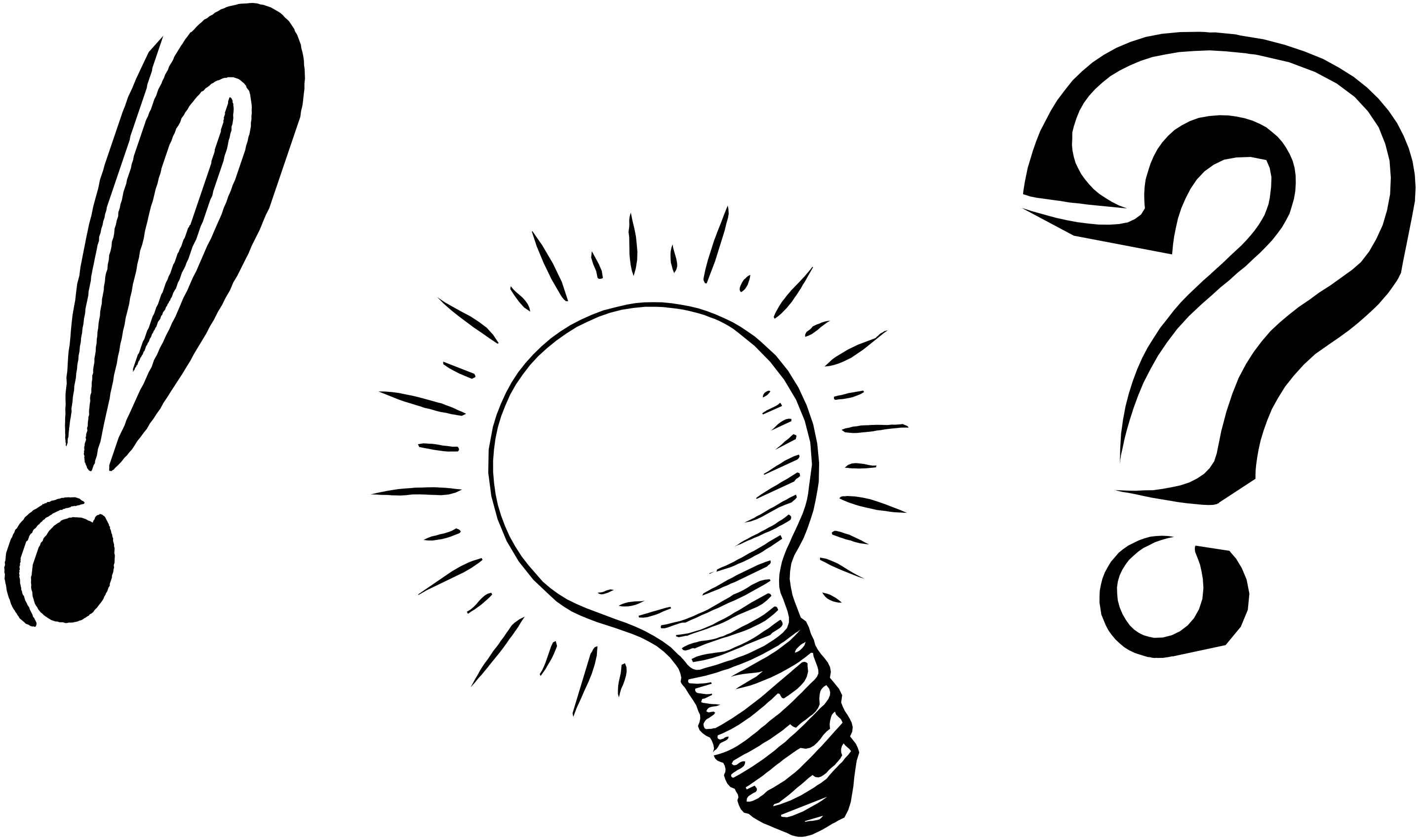
Tsunami

- Tsunami-like impacts on new acquisition training requirements
  - Rapid, large-scale disturbance of current training needs envisioned
  - Forces will include technological, human capital, external and government needs
- Training departments have incorporated best acquisition practices into their training courses; however
  - Mapping of core competencies to training courses needs to be done
  - Training architectures needed
- Developers of organizational training processes could benefit from the application of systems engineering



Images of the Ocean Floor

Wrap Up



Contact Information

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Using Simulation to Define and allocate probabilistic Requirements

Yvonne Bijan

Henson Graves

October 2009

Introduction

- General thesis
  - Integration of model-based system engineering with simulation in 3D synthetic environments is a cost effective way to design and analyze systems
- This is illustrated by
  - analyzing the feasibility of a proposed design to add terrain following and obstacle avoidance to an existing air vehicle
- Objective
  - Improve requirements by adding bounds to requirements based on analysis

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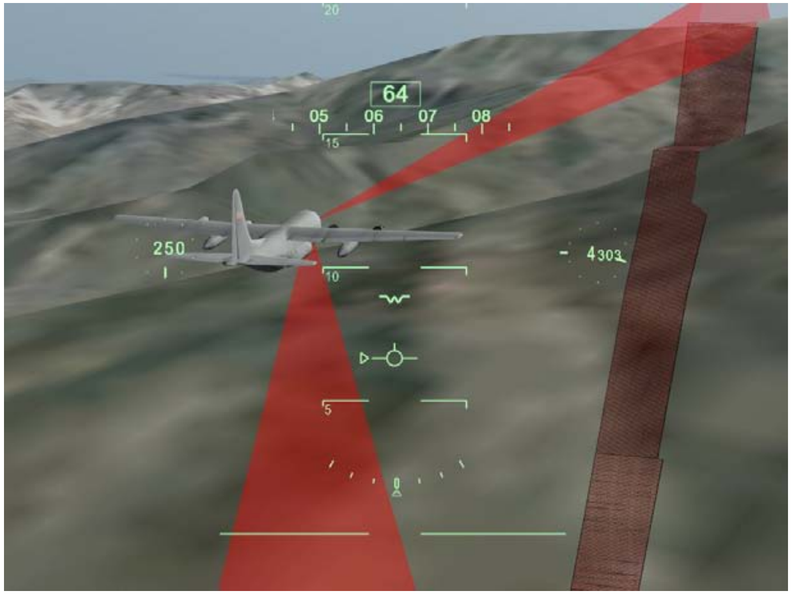
Engineering Application Example

- Problem
  - Determine if the proposed design solution will meet customer needs

- Work to be done
  - Refine requirements to make them bounded and precise
  - Determine critical environmental issues
  - Prototype design sufficiently to verify feasibility
  - Validate refined requirement with customer

Initial Requirement For Design Upgrade

- Initial requirement
  - avoid terrain and obstacles while flying low over mountainous terrain to avoid detection

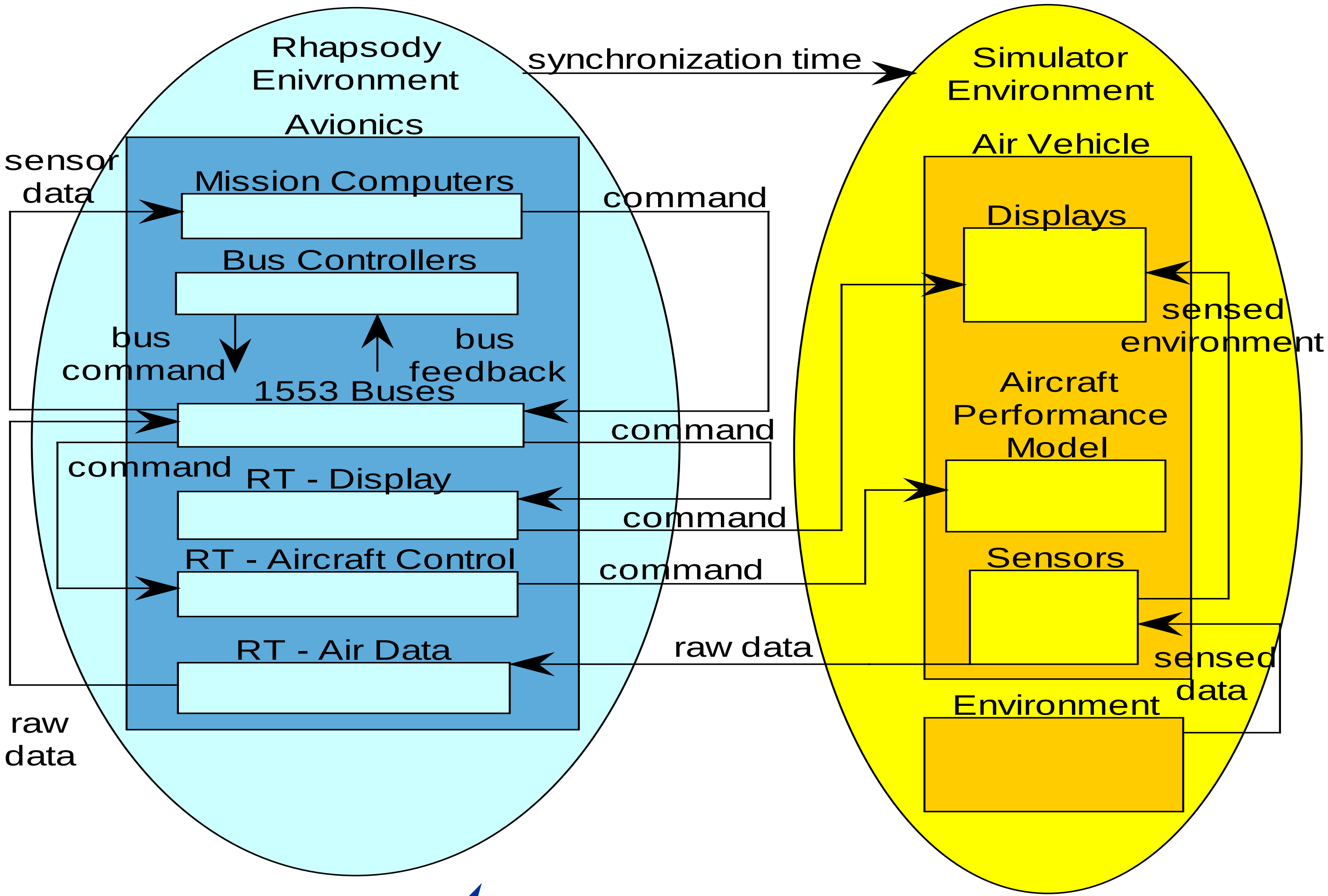


- Proposed design
  - specific radar integrated into the avionics system

Approach: Configure 3D Synthetic Environment

- Integrated radar data with avionics
- Performance model of aircraft
  - Climb rate
  - Velocity
- Sensor models
  - Detection distance
  - Sweep pattern
- Environment
  - Mountains
  - Obstacles
  - Weather

Approach: Integrated Executable Avionics Model With Simulation



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Approach: Model System and Environment

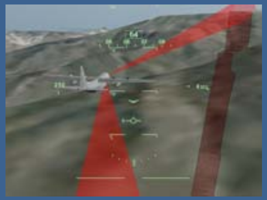
- Simulation developed to model the characteristics of the system and environment
- Run simulation multiple times varying all of the inputs
    - Collect results for statistical analysis

System Attributes

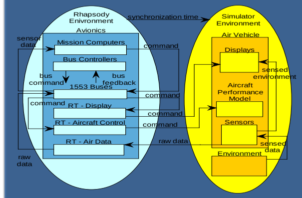
Aircraft speed
Aircraft climb rates
Radar power
Radar scan rates
Radar sweep pattern

Environmental Conditions

Obstacle Height
Obstacle Location



Simulation



Simulation Results

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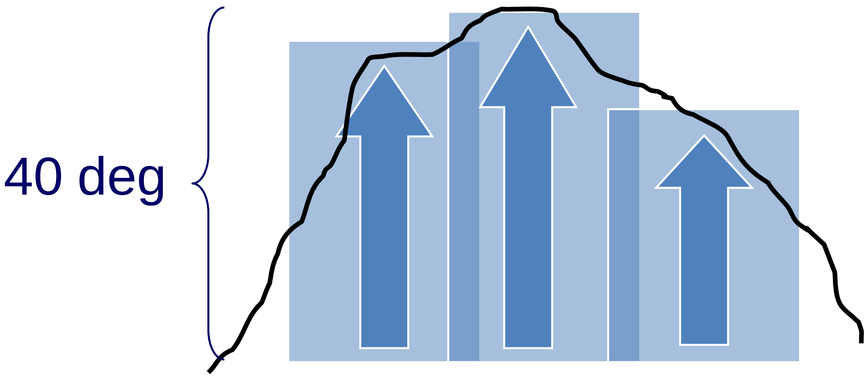
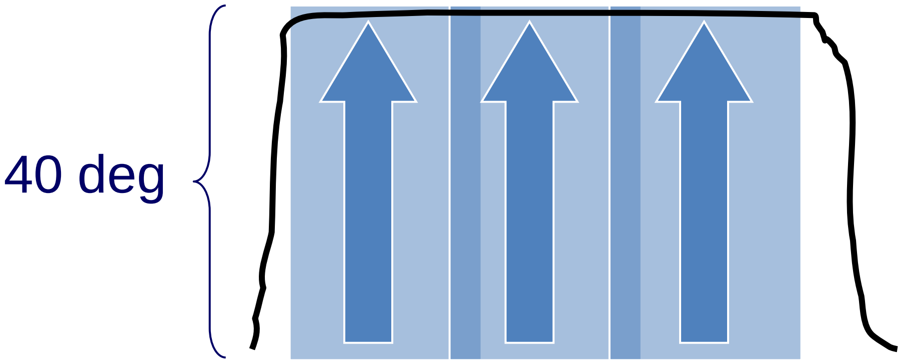
Scenarios – Terrain Variation

- Obstacle at height of max elevation range



- Obstacle at half height of max elevation range

- Plateau at max elevation range
  - Represents Full sweep



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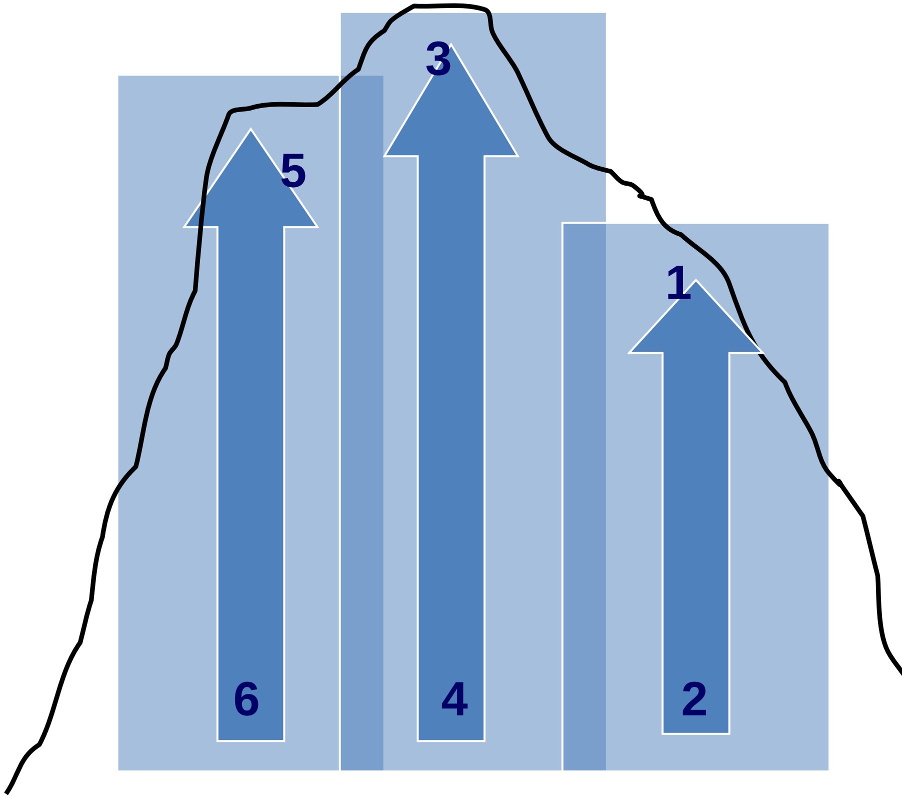
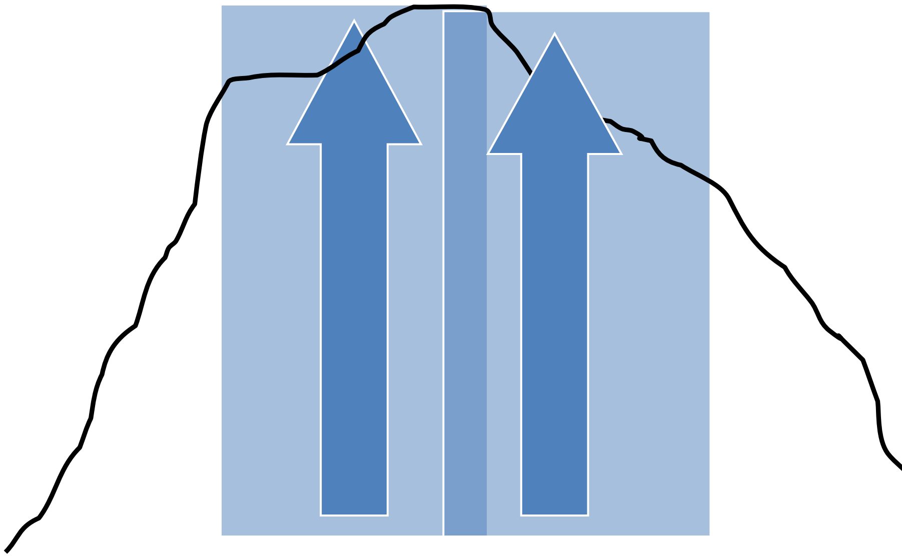
Scenarios - Scan Position Variation

- Top of the right bar
- Bottom of the right bar
- Top of middle bar
- Bottom of middle bar
- Top of left bar
- Bottom of left bar

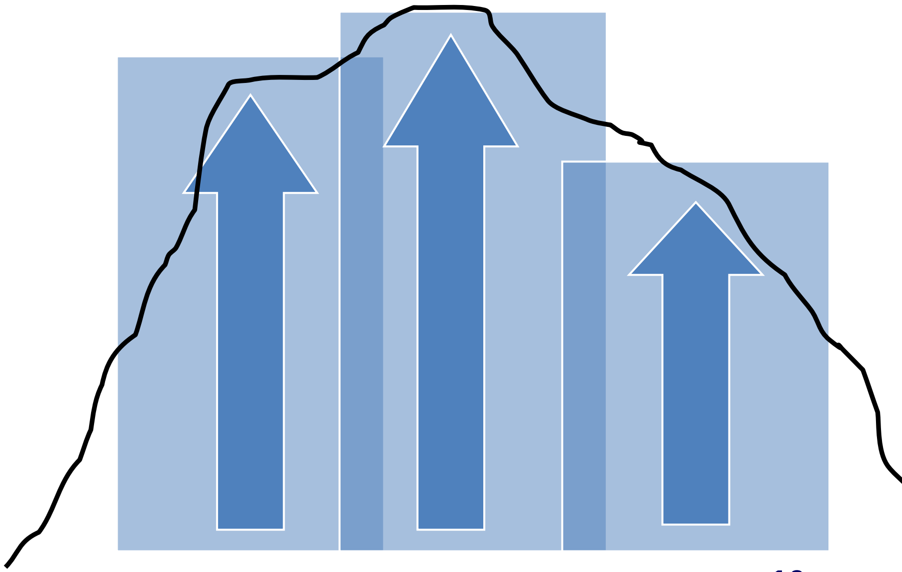


Scenarios - Scan Bars

- 2 scan bars
  - Faster



- 3 scan bars
  - More detail



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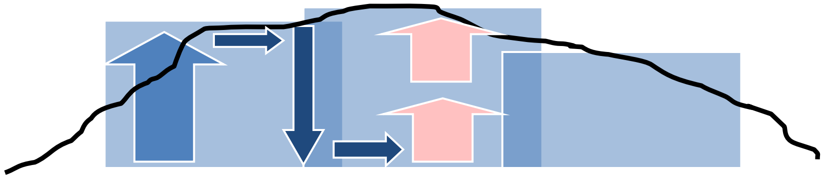
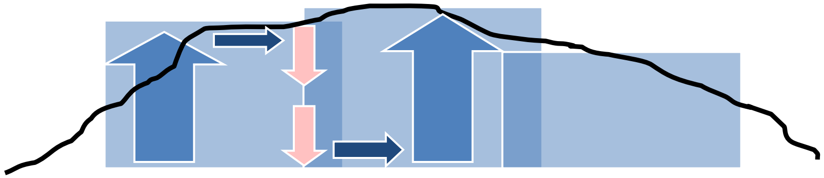
Scenario – Scan Rate Variation

- Normal rates

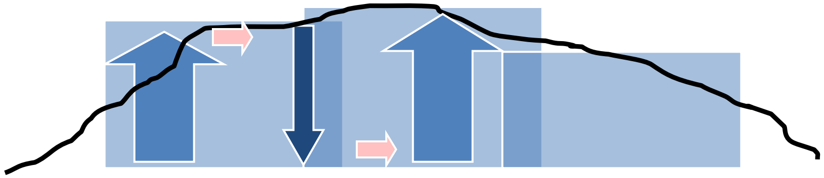
- Double up rate



- Double down rate



- Half turnaround



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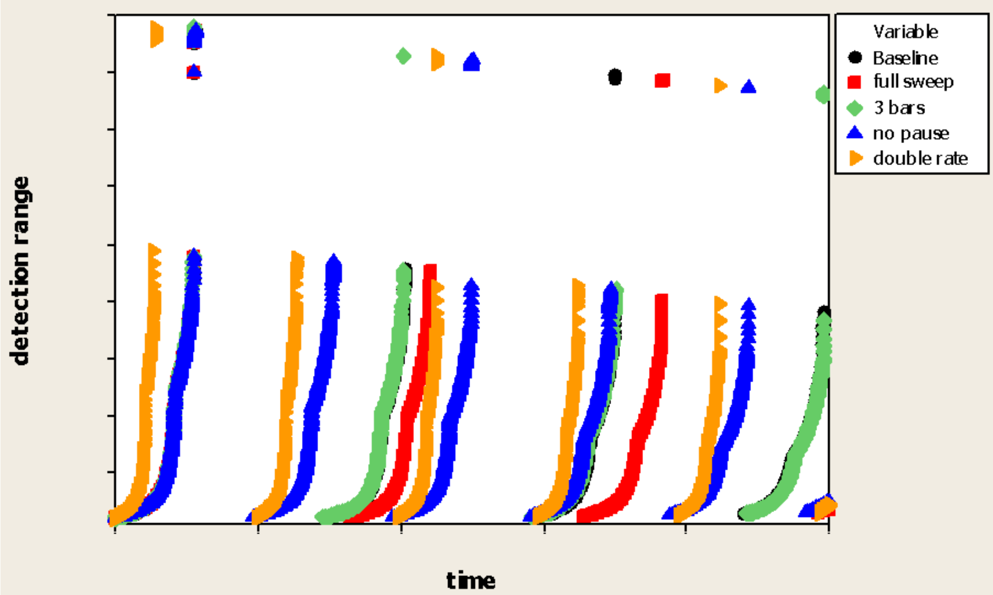
Data Collection From Simulations

- Velocity held constant
- 2 bars, normal pattern, normal rates
- 3 bars, normal pattern, normal rates
- 2 bars, normal pattern, double rates
- 2 bars, full pattern, normal rates
- 2 bars, no pauses for the sensor to turn around, normal rates

Detection Distance versus time for 5 runs



- Orange (Double scan rate) and Blue (Faster turnaround time) runs lead the others
- Red line (Full sweep) is slowest
- No difference between Black (baseline) and Green (more scan bars)

Simulation Results

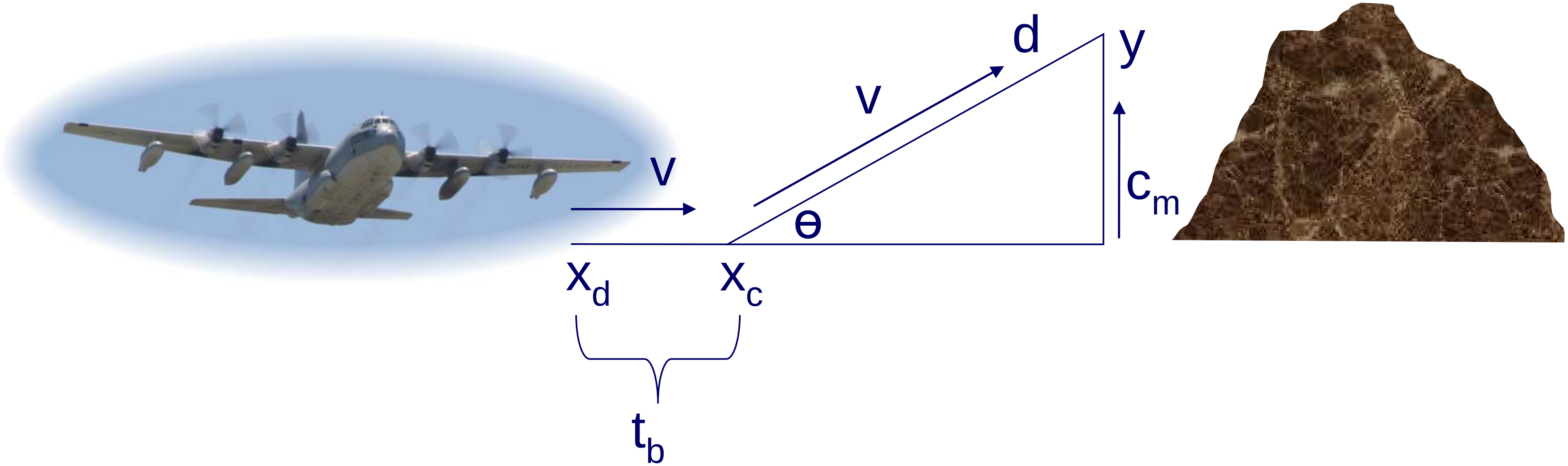
- Running the simulation
  - Showed what impacts the detection distance which in turn impacts the time budget
  - Showed the behavior of detection distance
  - Can put results and observation together to refine allocated detection requirements
    - Flight path impacted by
      - Airspeed
      - Climb rate
      - Detection distance
      - Obstacle height
      - Sweep pattern

Requirement

- Closer to a bounded requirement
- Aircraft shall compute a safe flight path within TBD seconds of detecting obstacles of TBD milliradians in size while flying level at an airspeed between TBD and TBD knots with an ability to climb at the rate of at least 2000 feet per minute.

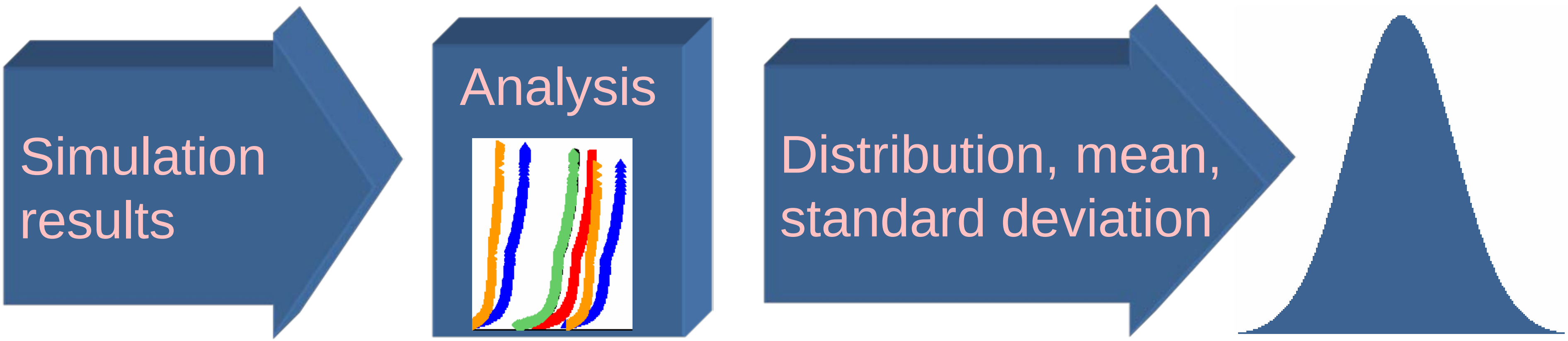
Analysis of Parameter Relationships

- Use physics to form equation with parameters that impact the time budget for safe flight computations



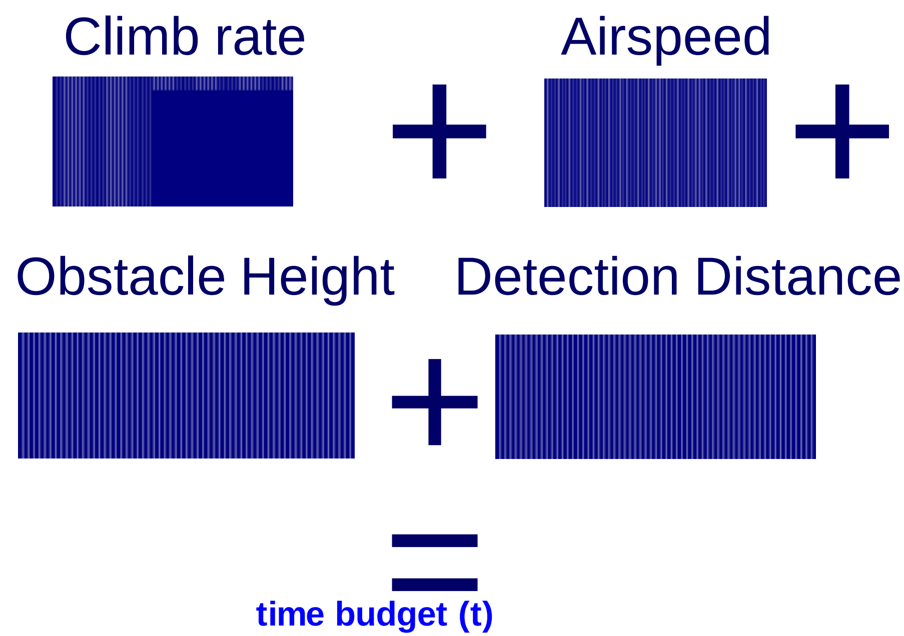
Analysis of Inputs

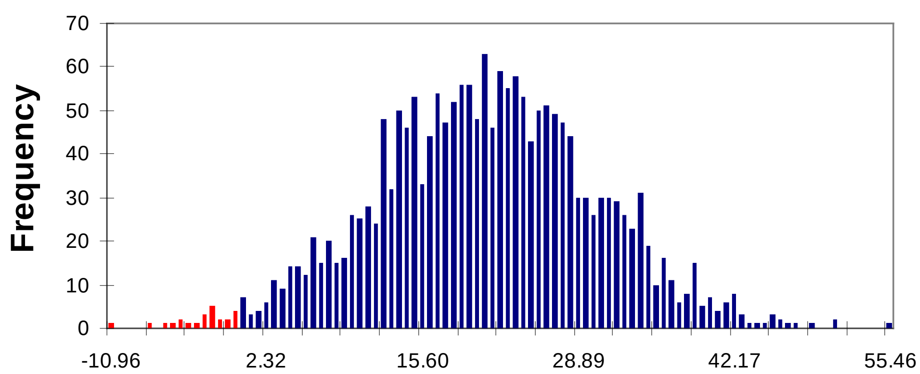
- Analyze each of the inputs to determine their distribution, mean and standard deviations.
- E.g. Run simulations on the input detection distance



Sensitivity Analysis To Determine Probability of Non Compliance

- Run a sensitivity analysis to determine the probability of compliance





Refined Requirement

- From: Avoid terrain and obstacles while flying low over mountainous terrain.

- To: Aircraft shall compute a safe flight path 99.98% of the time within 0.11 seconds of detecting obstacles of 0.5 milliradians in size while flying level at an airspeed between 200 and 280 knots with an ability to climb at the rate of at least 2000 feet per minute.

Conclusion

- Simulations help clarify environmental impacts
- Physics and geometry used to determine model
- Simulation with statistical analysis used to determine distribution and mean
- Sensitivity analysis to determine PNC

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IS&GS DEFENSE

A Systems Engineering Approach to Multi-Level Security in a Service Oriented Architecture

Tim Greer
Principal Systems Engineer
301-788-4882

LOCKHEED MARTIN

Presentation Overview

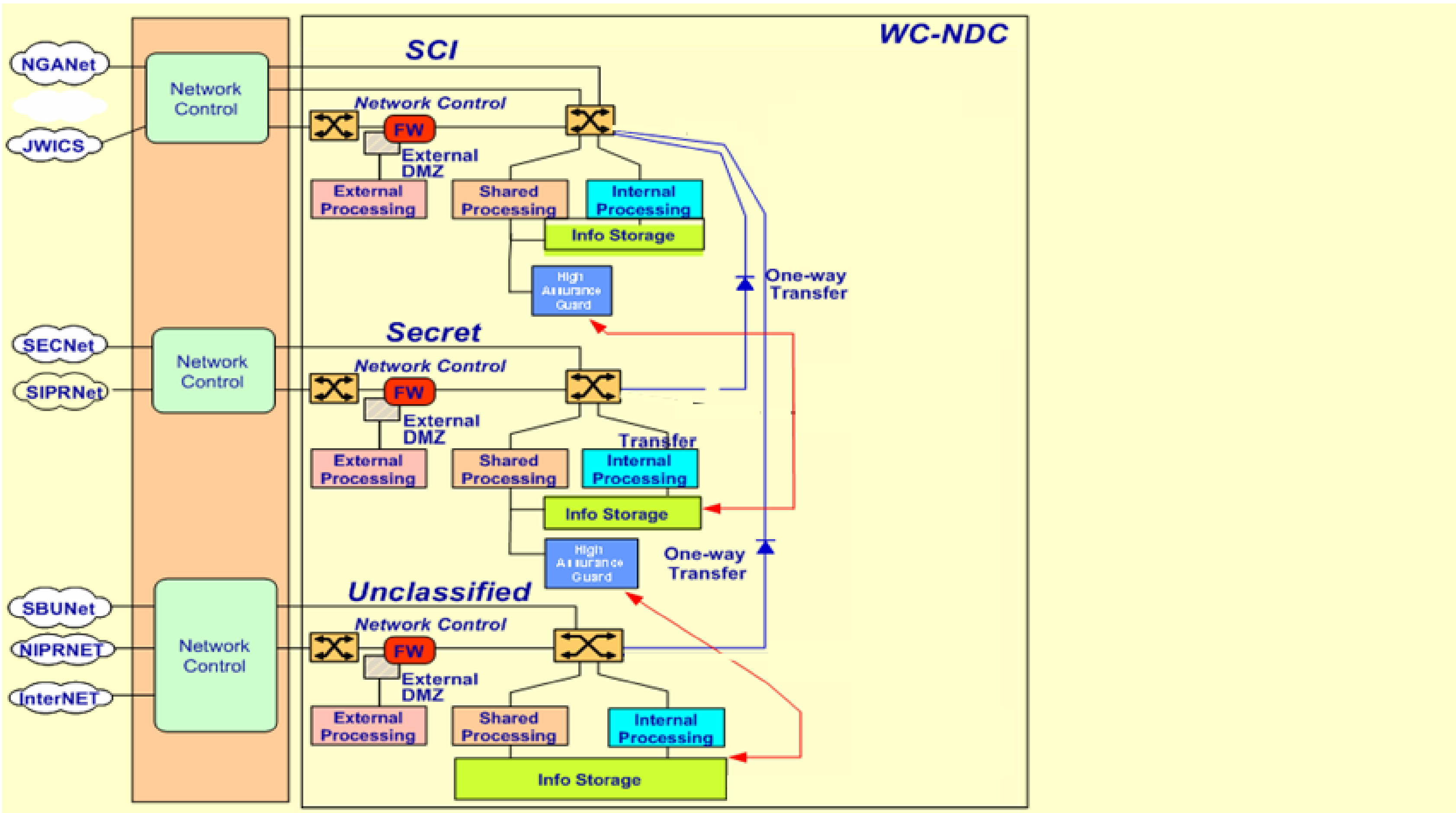
- Definitions
- Architecture Approach
  - Requirements Analysis
  - Security Layers – OEM Layers
  - Threats and Countermeasures
- Design Considerations
- Performance Considerations
- Cost Considerations
- Conclusion

Definitions

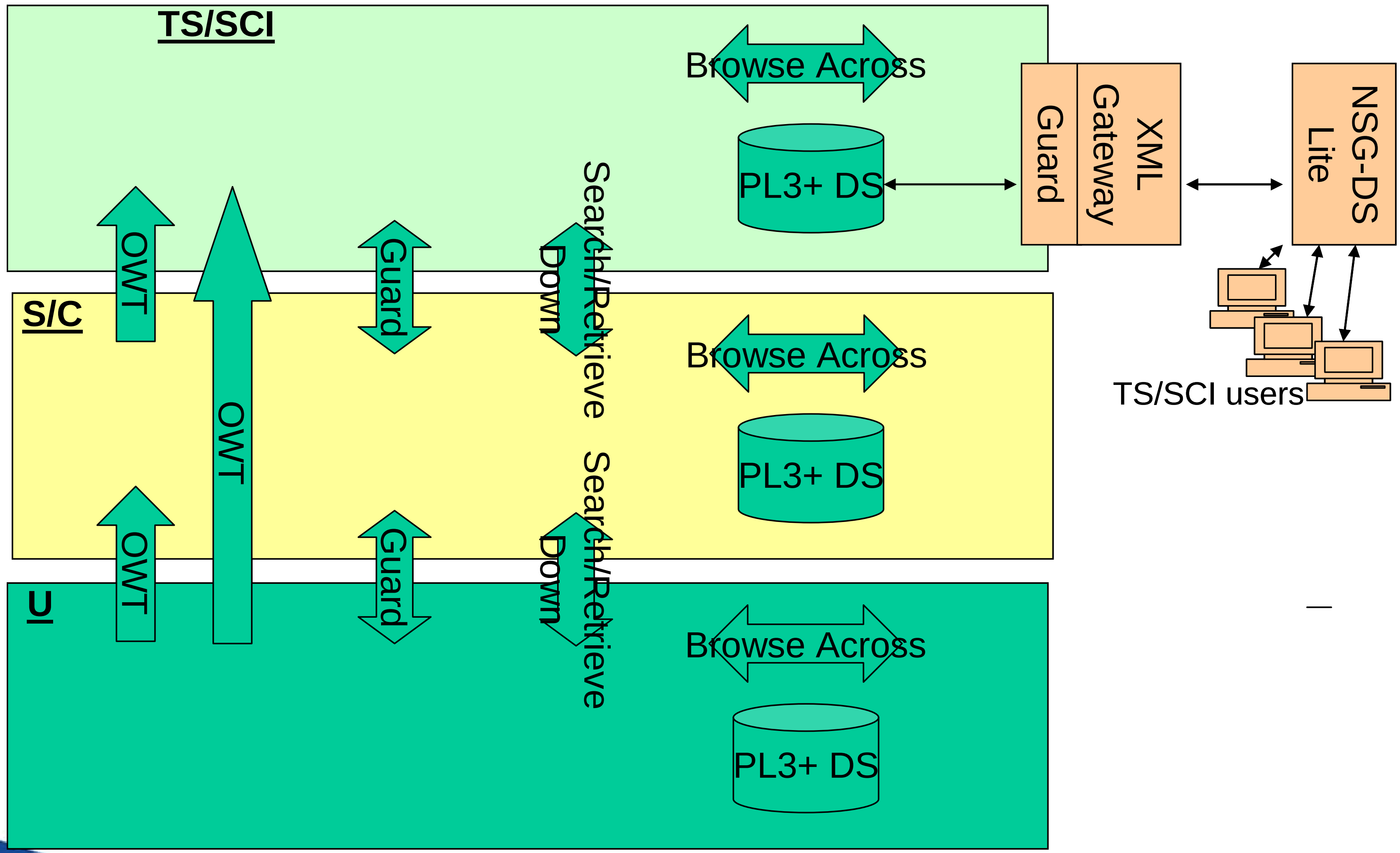
- Multi-Level Security (MLS) VS Multiple Security Levels (MSL)
  - MLS – Data from different security classification levels on the screen at the same time or
  - MLS – Data from different security classification levels or releasability restrictions stored in the same data base
  - MSL – Multiple security enclaves co-located but physically separated
  - MSL – Data from only one security enclave on a screen at a time – KVM switch may connect to workstation to multiple security enclaves – but each must be logged into separately

IS&GS DEFENSE

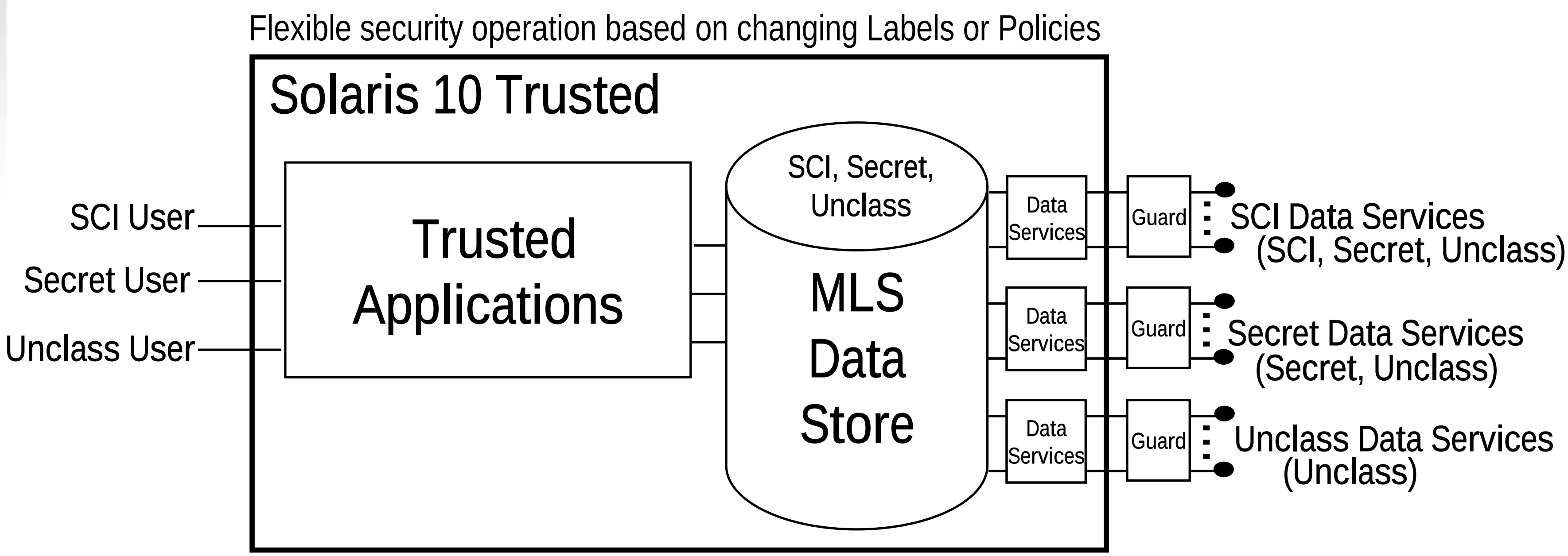
Multiple Security Levels (MSL)



Multi-Level Security - Definition 2



Multi-Level Security – Definition 1



Definitions

- Service Oriented Architecture
  - A standards-based architectural paradigm that enables mission processes through discovery and invocation of published, shared, discrete, and reusable mission and infrastructure services across a network
  - Designed to allow a community of service providers and consumers to achieve value by aligning services to mission processes and enabling better mission agility
  - Services are published, discoverable, invoked, and consumed
  - Services may be discovered and consumed either internally or externally to an enterprise
  - Services are designed to be predominantly loosely coupled however a family of services may be built and designed to work together

Definitions

- Authentication - Establishes, verifies, and identifies a person or a process – includes identity assertion.
- Authorization - The process of determining, by evaluating applicable access control information, whether a subject is allowed to have the specified types of access to a particular resource.
- Role Based Access Control (RBAC) – The process of restricting access to a service resource based on the roles associated with the consumer log in.

Requirements Analysis

- The following information must be collected prior to contacting the Designated Accreditation Authority (DAA)
  - The category, classification, and all applicable security markings for all of the information on, or to be put on, the system;
  - The need-to-know status of the users on the system, including their formal access approval(s), clearance(s), and nationality(ies);
  - The perimeter and boundary of the system;
  - The operating environment of the system and connecting systems, including the service provided (e.g., electronic mail, Internet access), and foreign access to the system, connecting systems, and the facilities housing these systems; and
  - The technical and administrative security requirements of the system.

Architecture – Requirements Analysis

- Security Requirements are often not explicitly stated
  - Look for:
    - Data transfer requirements
    - Access to a particular network or the internet requirements
    - Visualization of data requirements
    - Reference to a directive or standard requirements
    - Connection to applications or systems (interoperability) requirements
  - When connecting to networks like SIPRnet, JWICS, NGAnet, NSAnet, DIAnet, NIPRnet, CENTRIX
    - Contact the Designated Accreditation Authority (DAA)
    - Obtain the appropriate STIGS, SNAC Guides, DCID 6/3, MAC

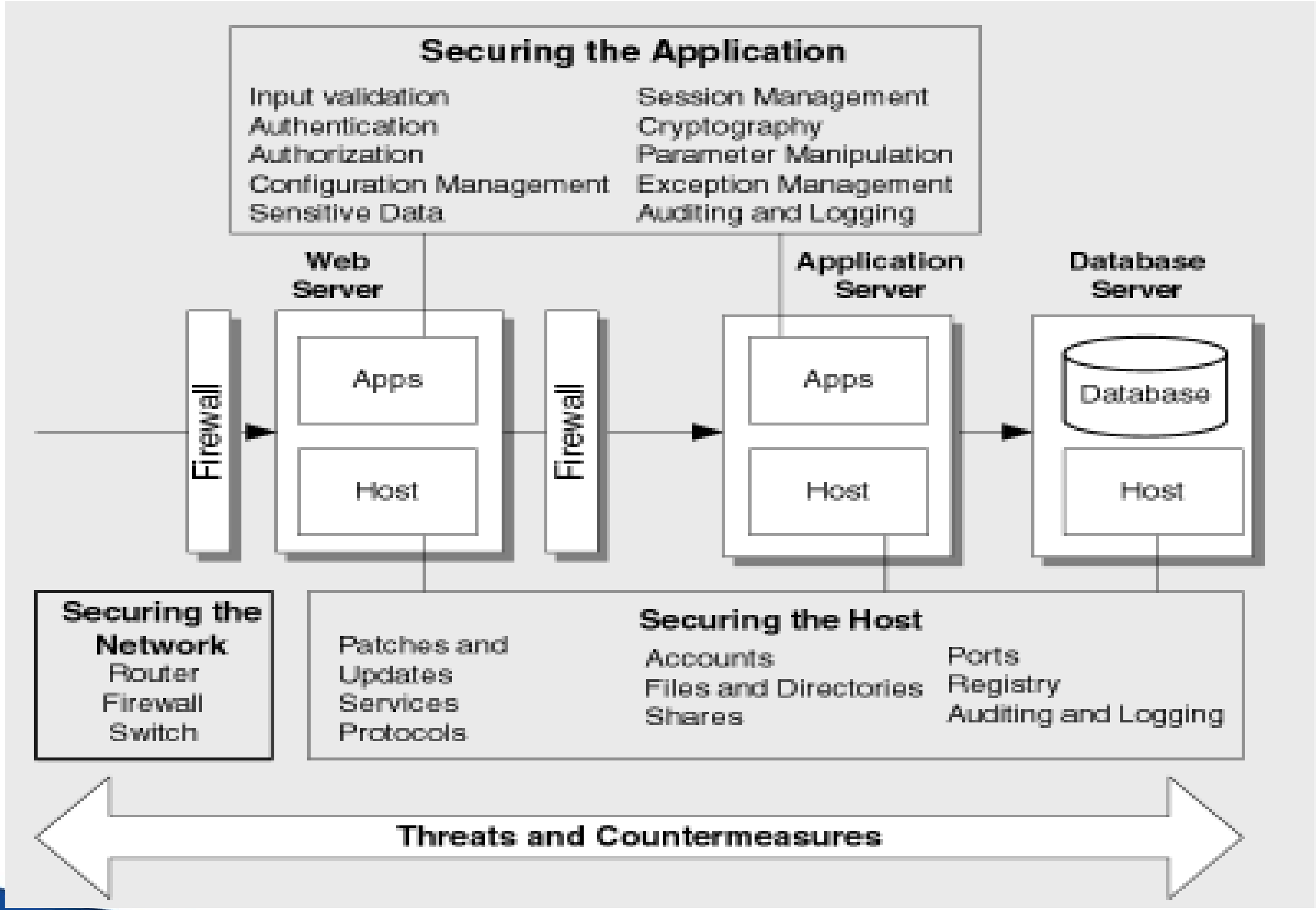
Dissemination Requirements

- **DCID 8 States:**
  - **Maximize Production of Intelligence at Multiple Security Levels.**
    - **Write-to-Release**
    - **Tearlines**
    - **Content Management**
    - **Data Tagging**
- **ICD 501 States:**
  - **IC elements shall have a predominant responsibility to:**
    - **Provide**
    - **Discover**
    - **Request relevant information**

Requirements Analysis

- DIACAP Training – http://iase.disa.mil/eta/diacap/diacap1/index.htm
- DCID and ICD guides
  http://www.fas.org/irp/offdocs/dcid.htm
- DCID 6/3 Online Manual http://www.fas.org/irp/offdocs/DCID_6-3_20Manual.htm
- *Intelligence Community Directive Number 501* *www.dni.gov/electronic_reading_room/**ICD_501**.pdf*
- DoD Metadata Specification https://metadata.dod.mil/mdr/irs/DDMS/

Threats & Countermeasures



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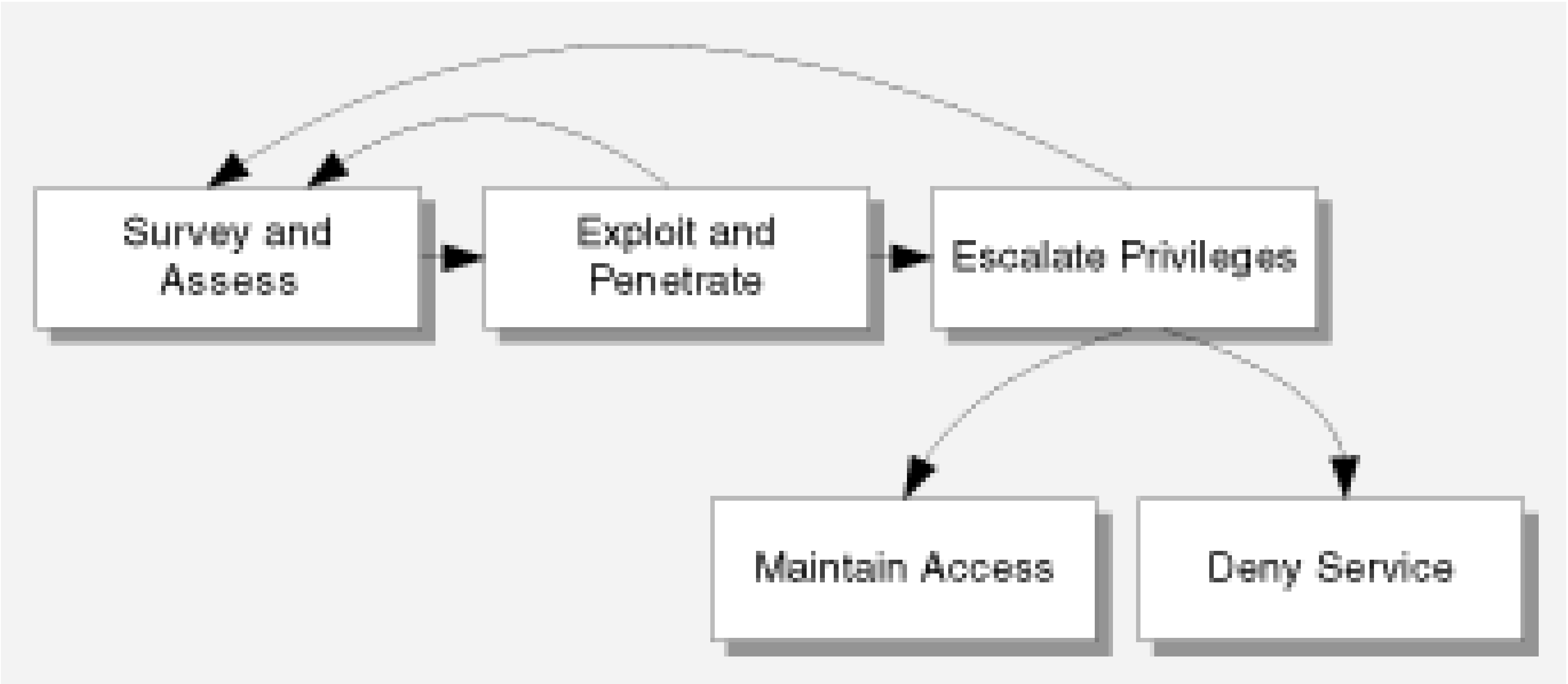
Anatomy of a Threat



Threats

- **Spoofing**
- **Tampering**
- **Repudiation**
- **Information disclosure - Sniffing**
- **Denial of service**
- **Elevation of privileges**
- **Session Hijacking**

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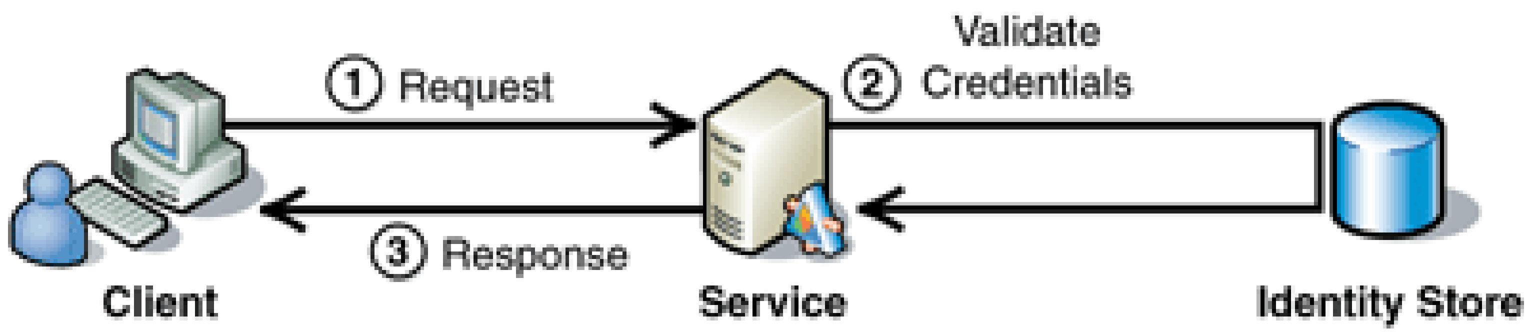
Countermeasures

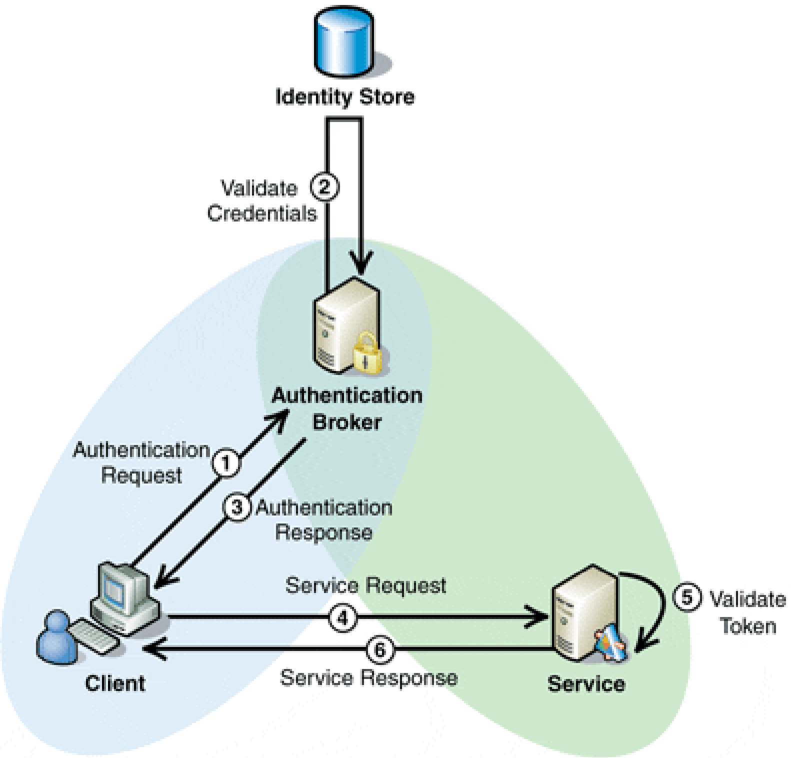
- Spoofing **– Strong Authentication (Cetificates) – Mutual Authentication – SSL - Encryption**
- Tampering **– Strong Authorization – Data Hashing – Digital Signatures – Message Validation Protocols**
- Repudiation **– Secure Audit Logs – Digital Signatures**
- Information disclosure – Sniffing – **Strong Encryption - SSL**
- Denial of service – **Intrusion Detection System (IDS) – Defense in Depth – Buffering and Resource Throttling Techniques – Validate & Filter Input**
- Elevation of privilege **– XML Gateway – Use Least Privileged User Accounts**
- Session Hijacking – **Strong Encryption – Timestamp Synchronization & Re-authentication**

Design Considerations – Direct Authentication



Design Considerations – Brokered Authentication – Mutual Authentication

- Kerberos Ticket
- X.509 PKI Certifi
- STS



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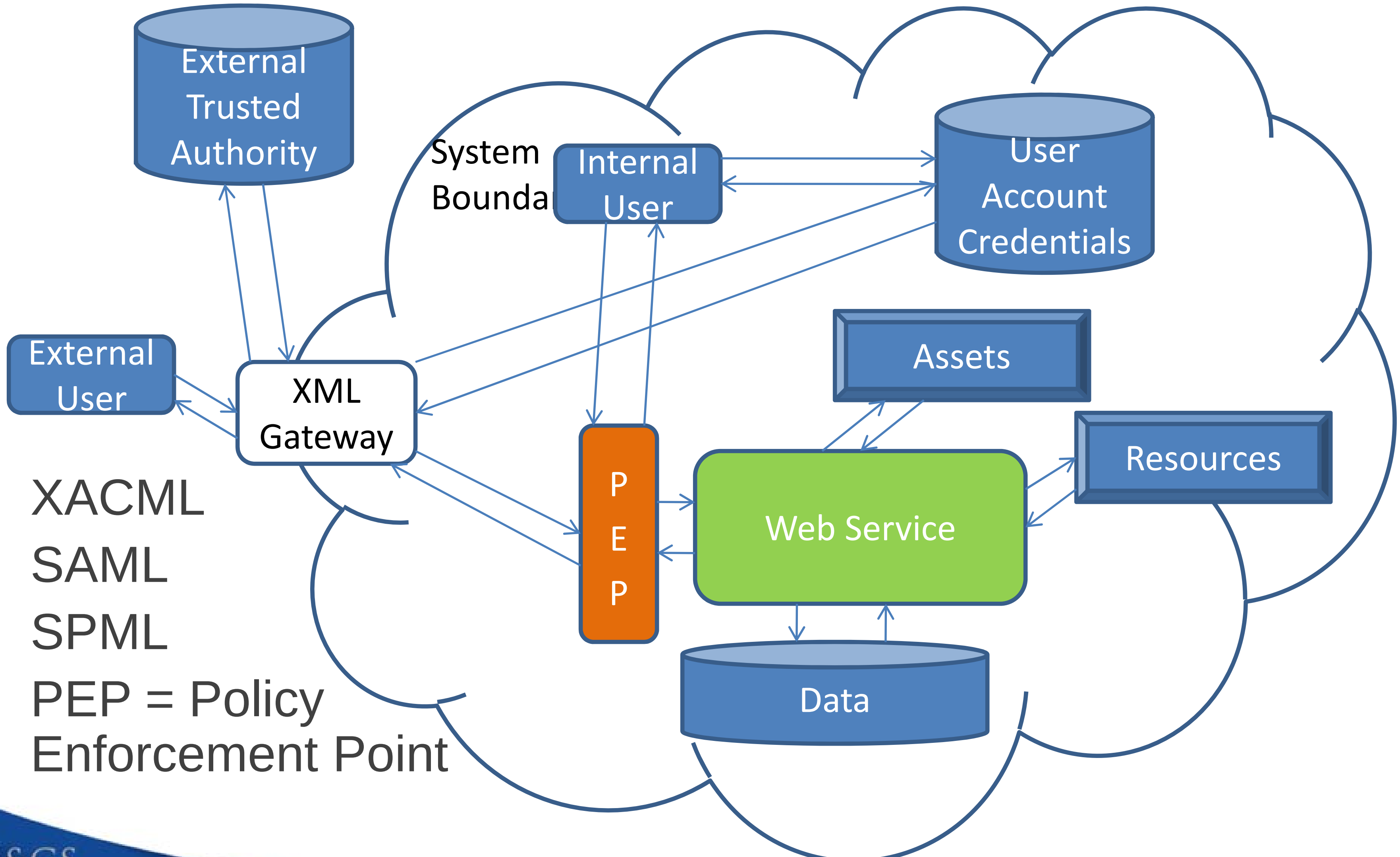
Message Layer VS Transport Layer Security

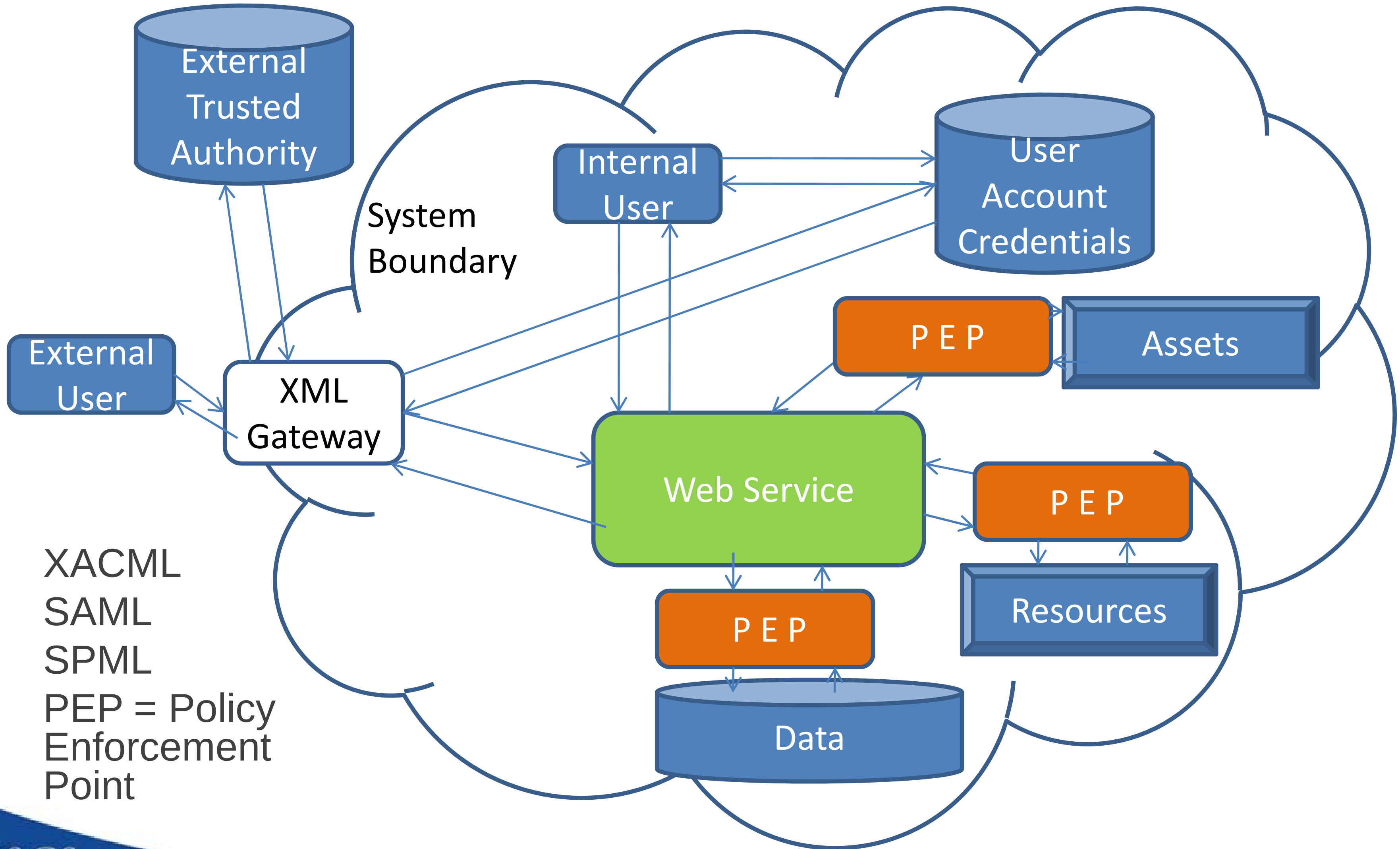
- Brokered Authentication can be implemented at the Message Layer or Transport Layer
  - Message Layer Security provides for
    - Data Confidentiality
    - Data Origin Authentication
    - Data Integrity
  - Message Layer Security is more complex
  - Transport Layer Security provides for
    - Minimal code and configuration work
    - With Kerberos can work across multiple system hops
  - Transport Layer is simpler – but does not provide Data Integrity – should be used with SSL
    - SSL can only be used point to point VS end to end

Policy Enforcement



- XACML
- SAML
- SPML
- PEP = Policy Enforcement Point

Policy Enforcement



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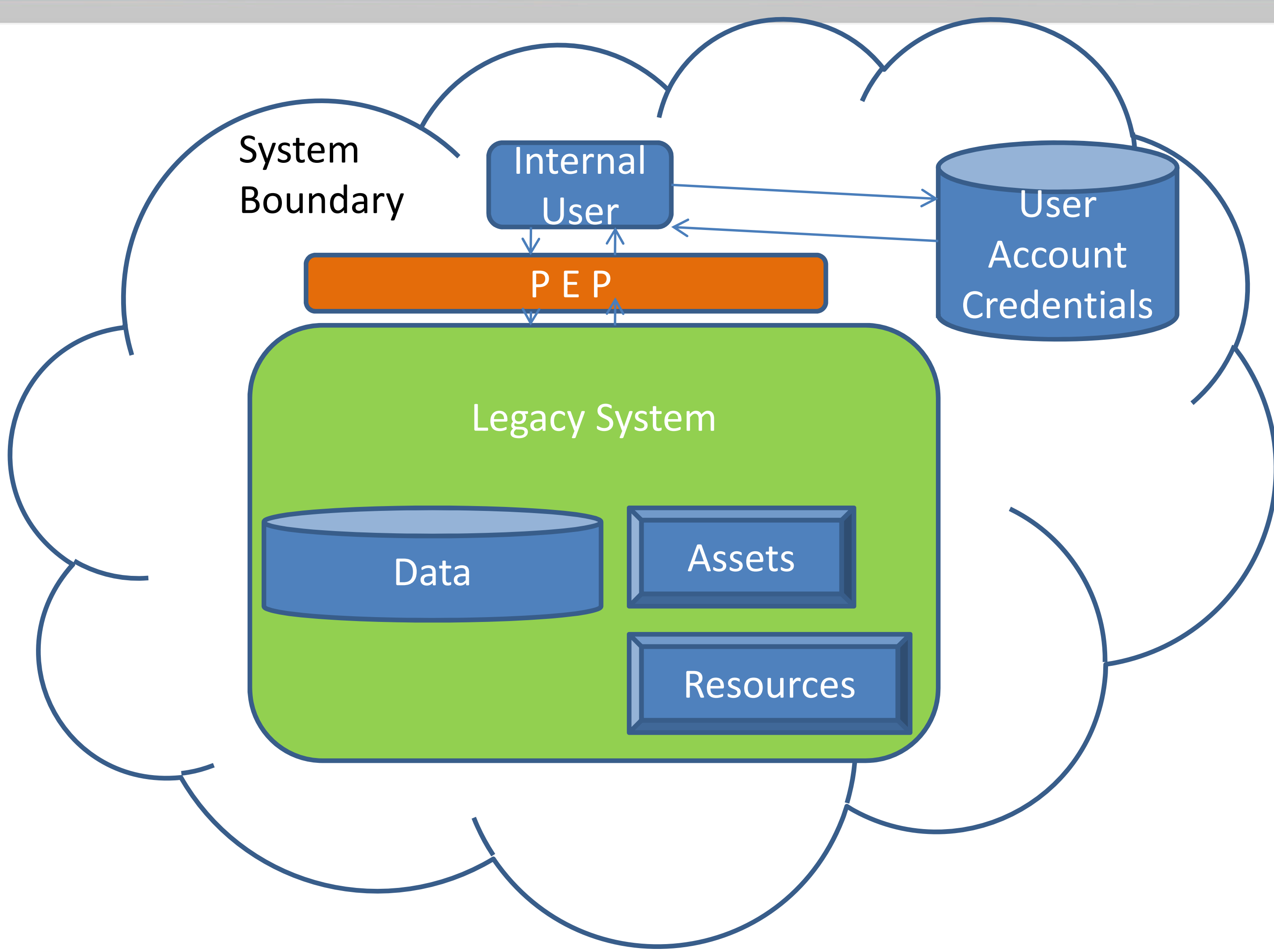
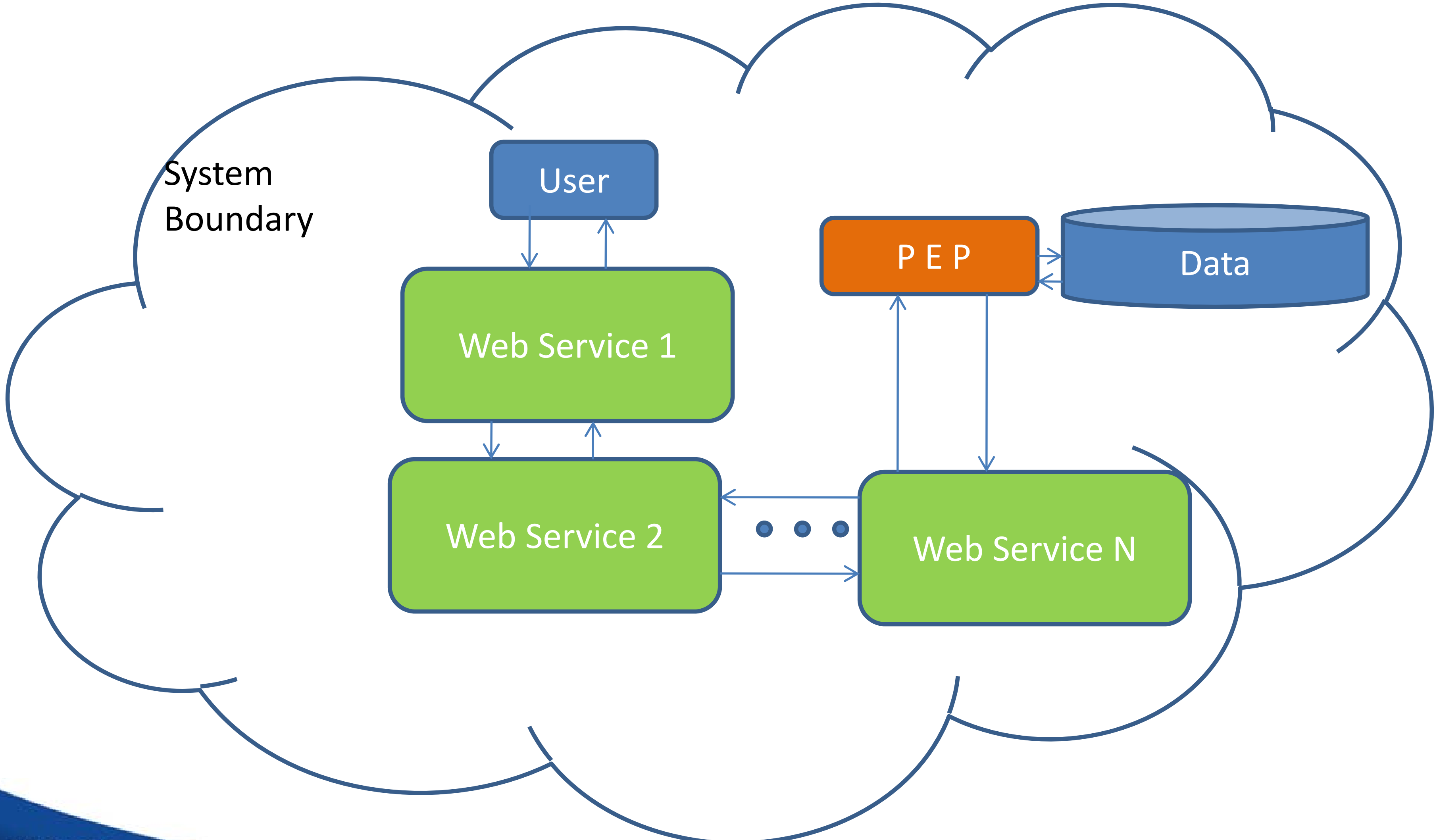
Policy Enforcement



Trusted Subsystem



Logging and Auditing

- Ensure all audit records include date and time of action, the system locale of the action, the system entity that initiated or completed the action, the resources involved, the action involved, and successful and unsuccessful logons and logoffs.
- Protect the contents of audit trails against unauthorized access, modification, or deletion.
- Maintain collected audit data at least 5 years and review at least weekly.
- Maintain an audit trail that includes selected records of: Accesses to *security-relevant* objects and directories, including opens, closes, modifications, and deletions.
- Maintain an audit trail that includes activities at the system console (either physical or logical consoles), and other system-level accesses by privileged users.
  - Individual accountability (i.e., unique identification of each user and association of that identity with all auditable actions taken by that individual).
  - Periodic testing by the ISSO or ISSM of the security posture of the IS by employing various intrusion/attack detection and monitoring tools.

Cost and Performance

Criteria	Definition	Rank	Weight
Standard Evaluation Criteria			
Cost	Includes both the recurring and non-recurring costs. Include labor, resources and any lifecycle charges.	5 – Very Low Cost Impact 4 – Low Cost Impact 3 – Medium Cost Impact 2 – High Cost Impact 1 – Very High Cost Impact	15%
Meets Requirements	Indicates the ability of a solution to fully and or partially meet the requirements defined in the A-specification and B-Specification	1 – Very Low Meets Requirements 2 – Low Meets Requirements 3 – Medium Meets Requirements 4 – High Meets Requirements 5 – Very High Meets Requirements	20%
Install Base	Defines how widely used a solution is and how many users may be trained on the solution today. Not specifically meant to portray commercial use, it also includes GOTS standards that have been adopted by gov't agencies.	1 – Very Low Install Base 2 – Low Install Base 3 – Medium Install Base 4 – High Install Base 5 – Very High Install Base	5%
Performance	Indicates the speed and quality at which a solution executes its functions. If possible, it should be based on hard execution data. If this is not feasible, the measure can be based on the architectural choice made that may enhance or impede performance. It also considers the consistency of the performance for all the users	1 – Very Low Performance 2 – Low Performance 3 – Medium Performance 4 – High Performance 5 – Very High Performance	10%

IS&GS DEFENSE

Cost and Performance

Criteria	Definition		Rank	Weight
Standard Evaluation Criteria				
Dependencies	Defines the number of strict needs the solution requires to operate. These dependencies can be at the infrastructure level or at the system level. Should be an indicator of how easy it will be to integrate the solution.	5 – Very Low Dependencies 4 – Low Dependencies 3 – Medium Dependencies 2 – High Dependencies 1 – Very High Dependencies	5%	
Certification & Accreditation	Indicates if the solution has been accredited previously. If not, it should provide some measure that indicates if it would be easily accredited based on similar products, its lifecycle, its implementation etc…	1 – Very Low Certification & Accreditation 2 – Low Certification & Accreditation 3 – Medium Certification & Accreditation 4 – High Certification & Accreditation 5 – Very High Certification & Accreditation	5%	
Interoperability	Defines the solution's capability to interoperate with diverse systems and infrastructure capabilities. Indicates if the solution is based on open (non-proprietary) standards, that it has exposed interfaces and is adaptable to many environments. This also includes the product's ability to operate in service oriented environment.	1 – Very Low Interoperability 2 – Low Interoperability 3 – Medium Interoperability 4 – High Interoperability 5 – Very High Interoperability	5%	
Reliability	Measures a solution's ability of a system to perform and maintain its functions in routine circumstances, as well as hostile or unexpected circumstances. Systems with no track record or with complex, unreliable software will probably score lower.	1 – Very Low Reliability 2 – Low Reliability 3 – Medium Reliability 4 – High Reliability 5 – Very High Reliability	5%	

Cost and Performance

Criteria	Definition	Rank	Weight
Standard Evaluation Criteria			
Manageability	Requires the product to be capable of being managed in a production	1 – Very Low Manageability 2 – Low Manageability 3 – Medium Manageability 4 – High Manageability 5 – Very High Manageability	5%
Scalability	Defines a products capability to add additional hardware or software to the system for additional load (i.e. additional users, messages, clustering).	1 – Very Low Scalability 2 – Low Scalability 3 – Medium Scalability 4 – High Scalability 5 – Very High Scalability	5%
SWAP Impact	Defines the impact on the existing deployed system for space, weight and power availability.	5 – Very Low Hardware Impact 4 – Low Hardware Impact 3 – Medium Hardware Impact 2 – High Hardware Impact 1 – Very High Hardware Impact	15%
Flexibility	Defines the additional capabilities the product adds to the trade over and above the basic requirements for solutions to other complexities of the system (i.e. real time changing of logging levels, monitoring of metrics, debugging of service transactions, configurable)	1 – Very Low Intelligence Community Standard 2 – Low Intelligence Community Standard 3 – Medium Intelligence Community Standard 4 – High Intelligence Community Standard 5 – Very High Intelligence Community Standard	2.5%
Intelligence Community Standard	Defines the compliance with DCID 6/3.	1 – Very Low Intelligence Community Standard 2 – Low Intelligence Community Standard 3 – Medium Intelligence Community Standard 4 – High Intelligence Community Standard 5 – Very High Intelligence Community Standard	2.5%

Gartner's Magic Quadrant

Focus on Tomorrow

Ability to Execute

(In Technology, visibility, services, features)

Challengers	Leaders
Execute well today or may dominate a large segment, but does not yet understand market direction	Executes well today and is well-positioned for tomorrow
Focuses successfully on a small segment, or is unfocused and does not out innovate or outperform others	Understands where the market is going or has a vision for changing market rules, but does not yet execute well
Niche Players	Visionaries

Accreditability

- Evaluation by independent Laboratories – Common Criteria
  http://www.commoncriteriaportal.org/
- Early Engagement of DAA
- Thorough testing using the STIGS, SNAC Guides and other guiding documents
- Well documented architecture
- Well documented system and operational procedures

Conclusion

- Engage DAA Early
- Requirements Analysis early and complete
- Identify Threats
- Determine Countermeasures
- Evaluate Architecture Alternatives
- Balance Cost, Performance, Security through Analysis of Alternatives exercise
- Leverage Existing Capabilities While Implementing New Technologies

IS&GS DEFENSE

A Systems Engineering Approach to Multi-Level Security in a Service Oriented Architecture

Tim Greer
Principal Systems Engineer
301-788-4882

QUESTIONS

LOCKHEED MARTIN

Applying Systems Engineering to Operational System Improvements

12th Annual Systems Engineering Conference

October 29, 2009

Presented by:

Ryanne Gentry
Acquisition Logistics Engineering

6797 North High Street, Suite 324; Worthington, OH 43085 – (614) 436-1609 – FAX (614) 436-1295
4850 Gautier-Vancleave Road, Suite 3; Gautier, MS 39553 – (228) 522-1522 – FAX (228) 522-1505
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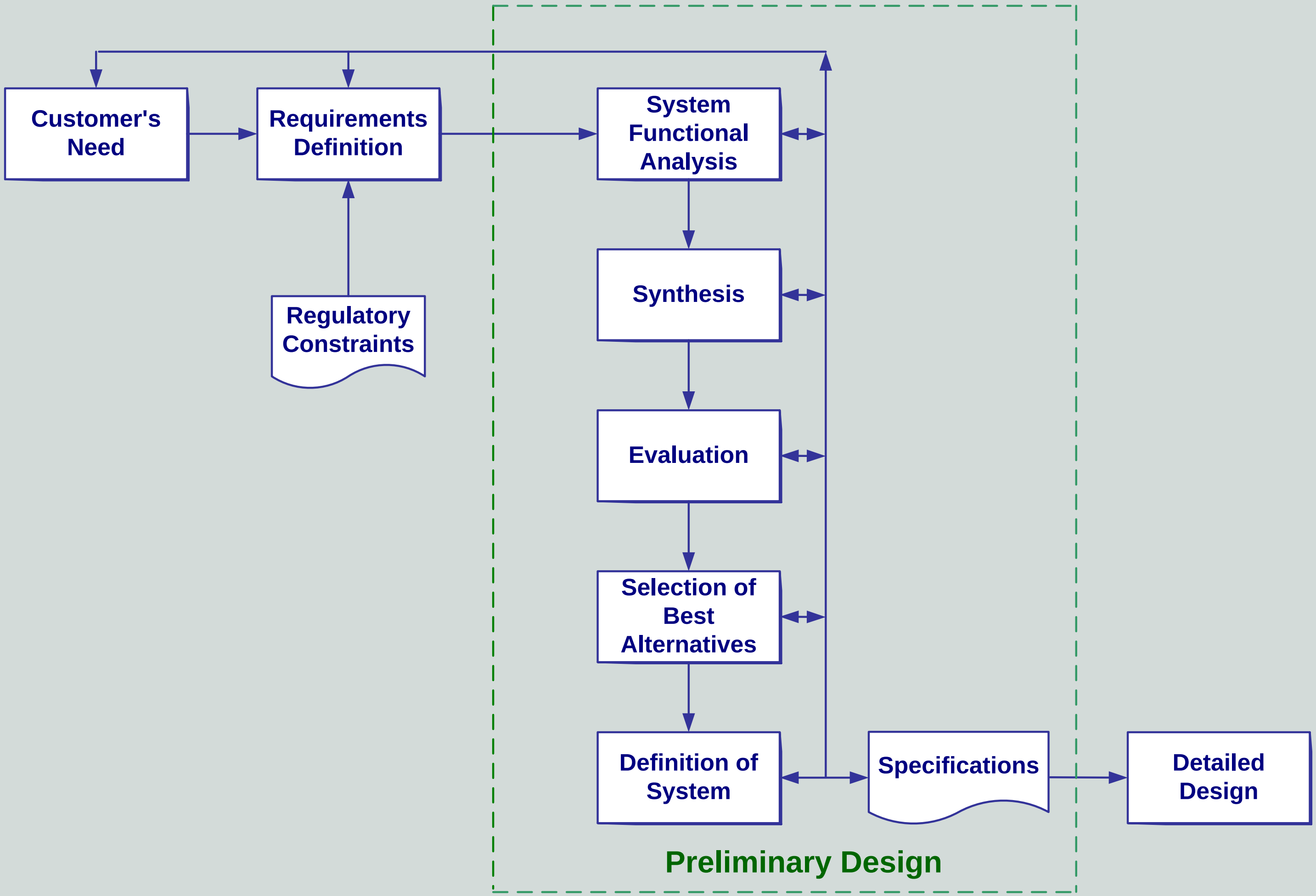
OVERVIEW

- Current need to reduce cost while improving performance of Legacy Systems
- Definition of Classic Systems Engineering Process
- Example application and Case Study
- Where to from here?

CLASSIC SYSTEMS ENGINEERING PROCESS



An orderly approach to meeting customer needs through detailed design.

POTENTIAL APPLICATIONS

CASE STUDY: TAXI CAB

- **Company Objective: Increase Profitability**
- **Approach: Systems Engineering**
- **Facts: 100 Vehicles, 75,000 Miles/Year/Vehicle**
  200 Drivers, Management, Dispatch, Advertising, Health Insurance, Auto Insurance, Vehicle Support (Repair, Fuel, etc.)

REQUIREMENTS

Full set of requirements constrain the solution space.

BASELINE COST ESTIMATE

Appropriate cost elements for the particular customer

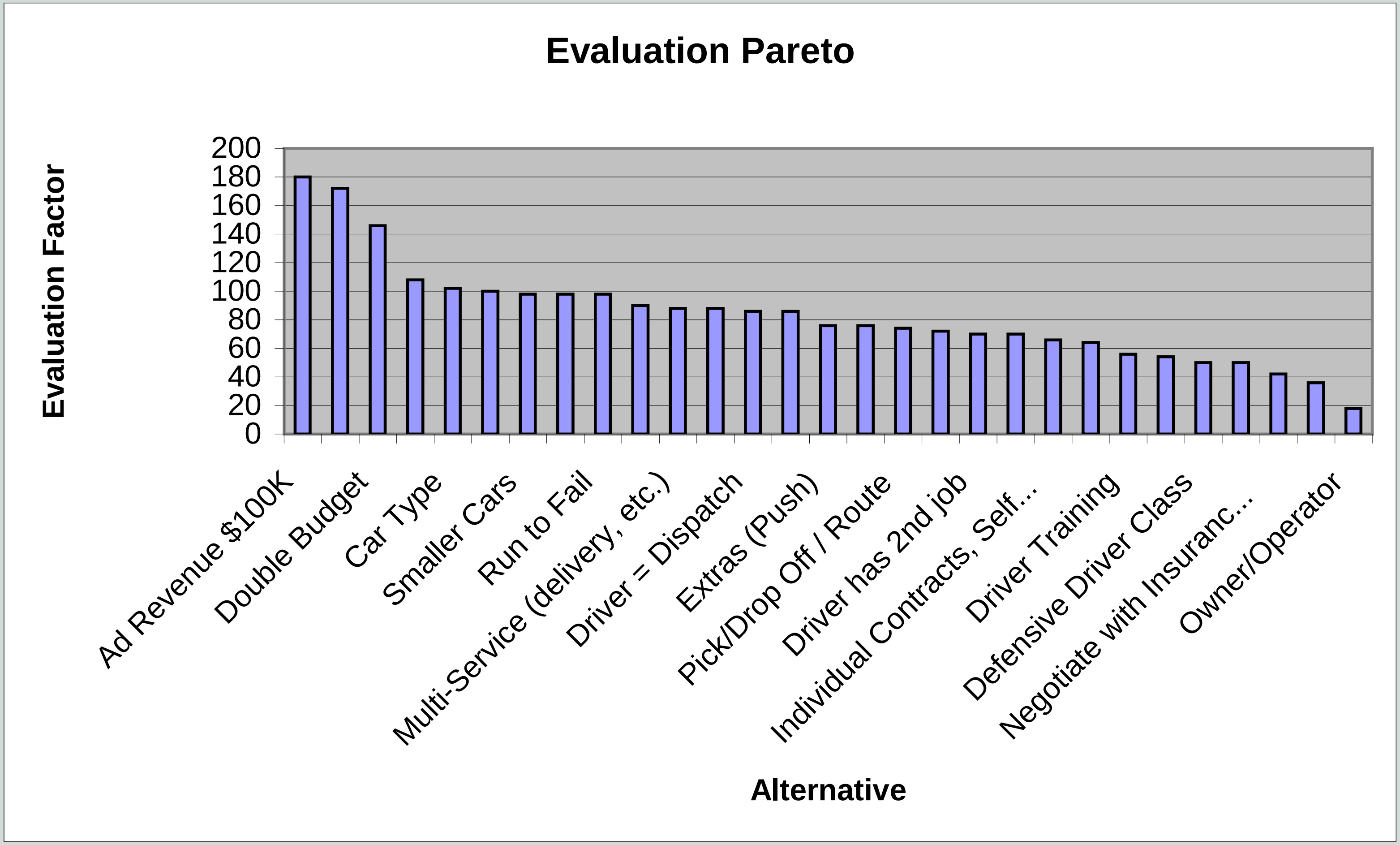
Cost Element	Cost / Year
Total Cost	**$10,500,000**
Total Labor	**$4,340,000**
Driver	$3,200,000
Dispatch	$140,000
Management	$1,000,000
Fuel	**$1,500,000**
Maintenance	**$1,200,000**
Vehicles	$700,000
Equipment	$500,000
Insurance	**$1,156,000**
Health	$856,000
Auto	$300,000
Vehicle Replacement	**$500,000**
Advertising	**$52,000**
Miscellaneous Cost (Rent, Utilities, etc.)	**$1,752,000**

ALTERNATIVES BY FUNCTION

- **Support**
  - Smaller Cars
  - Electric Cars
  - Repair Contract
  - Run to Fail
  - Etc.
- **Insurance**
  - Self Insured Drivers
  - Negotiate with Insurance Companies
  - Hire Lawyers
  - Liability Only
  - Etc.
- **Driver Function**
  - Defensive Driver Class
  - Work for Tips Only
  - Robotic Driver
  - Pull Off & Wait
  - Etc.
- **Advertising**
  - Utilize Car In/Out
  - More Trips
  - Double Budget
  - New Media Outlet
  - Etc.

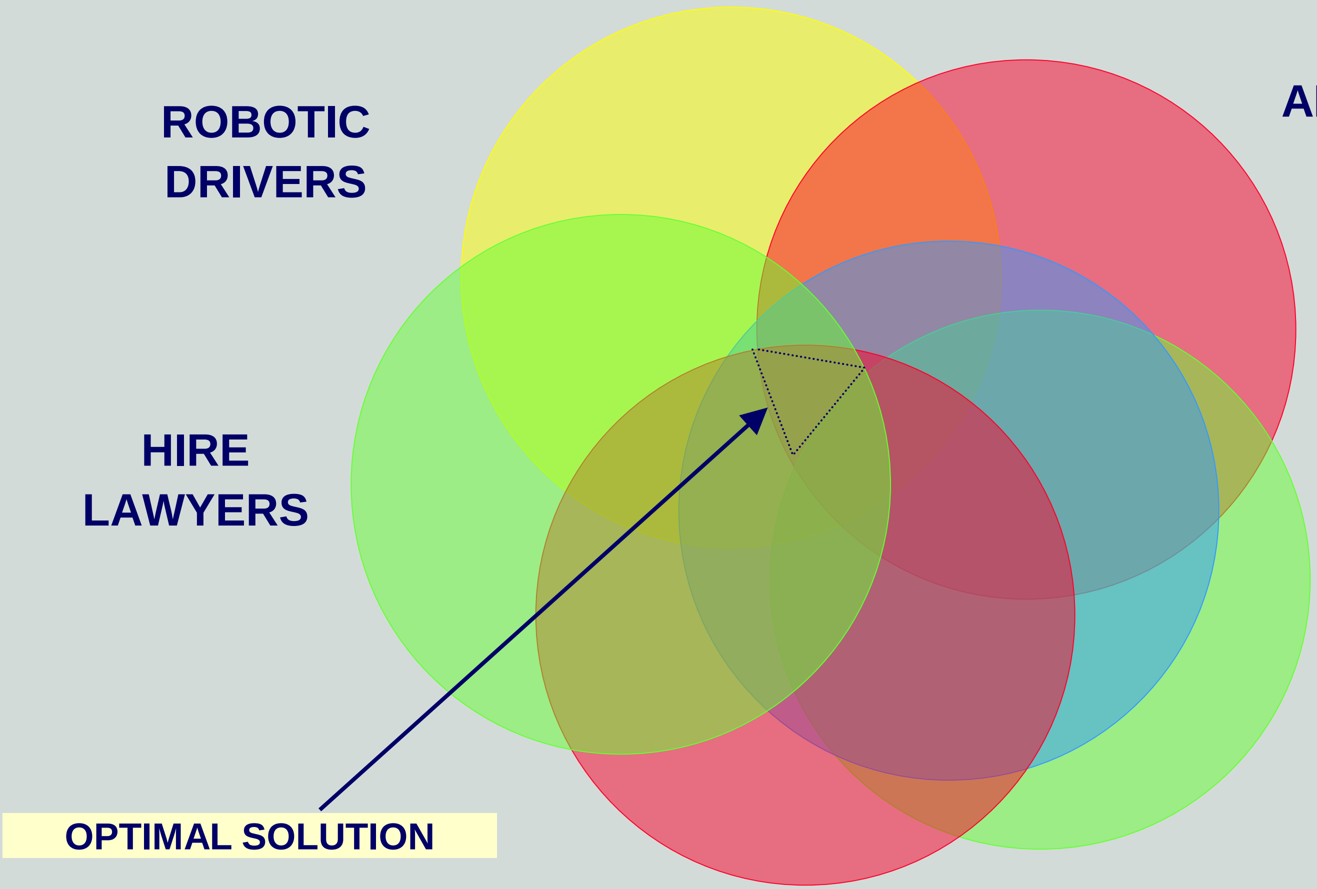
Broader analysis provides a wider range of opportunities.

ALTERNATIVE ANALYSIS



Concentrate on high cost centers.

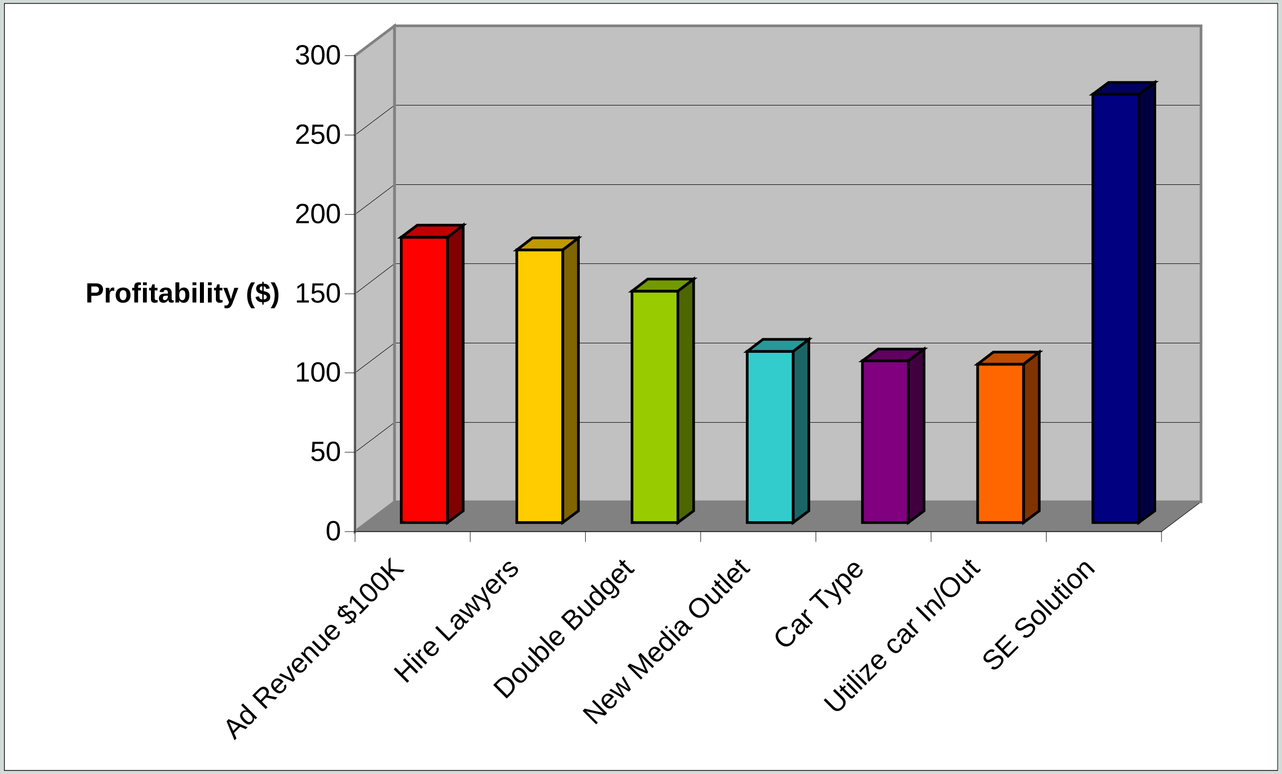
EVALUATION



The Best solution is cherry picked from several solutions.

RESULTS

Systems approach yields a better solution than any individual fix.



Systems Engineering solutions are typically two to three times better at meeting objectives.

WHERE TO FROM HERE?

How to train Systems Engineering practitioners
to work in legacy world.

Are you fired up, ready to go?

Fired up, ready to go?

Fired up, ready to go?

Fired up, ready to go?

Educating the Next Generation of Software Engineers

Nicole Hutchison

Art Pyster, Kahina Lasfer

NDIA SE Conference
October 2009

nicole.hutchison@anser.org

Discussion Topics

- How the world has changed
- The current state of software engineering education
- Creating and disseminating a new reference curriculum
- And next?

There are precious few interesting man-made systems whose success is not critically dependent on software.

Twenty years from now, software people will be sitting at the table and the other disciplines will be sitting around the sides of the room.

Eberhardt Rechtin, 1993

There are precious few interesting software systems anywhere whose success is not critically dependent on the developers practicing good systems engineering.

What do we teach for a master's degree in software engineering?

- The last effort to create a reference curriculum for graduate software engineering education was by the SEI in the early 1990s.
- There are, in effect, no current community-endorsed recommendations on what to teach software engineers – nothing that recognizes how the world has changed.
- Response: create a project to create a new reference curriculum in software engineering

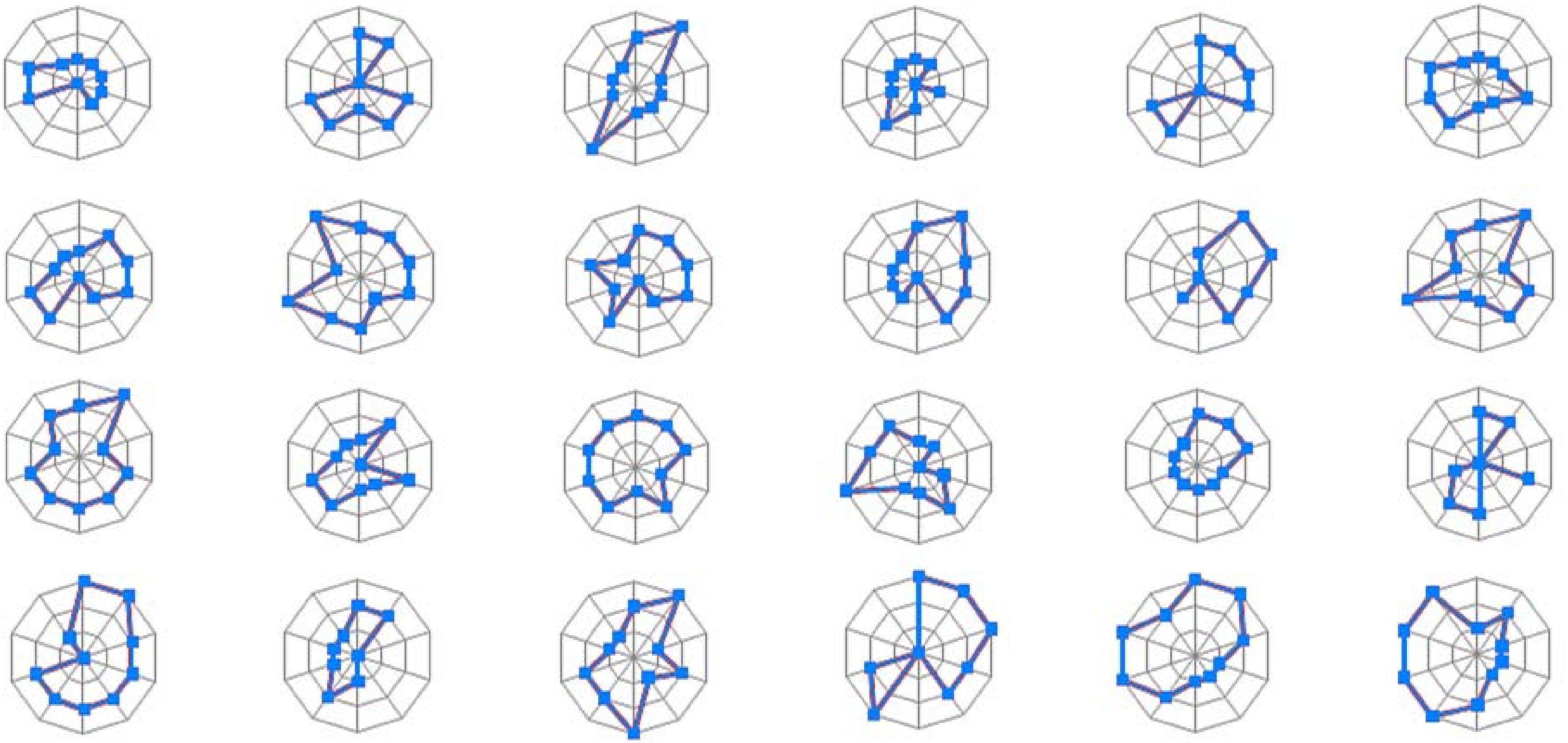
The Integrated Software and Systems Engineering Curriculum (iSSEc) Project

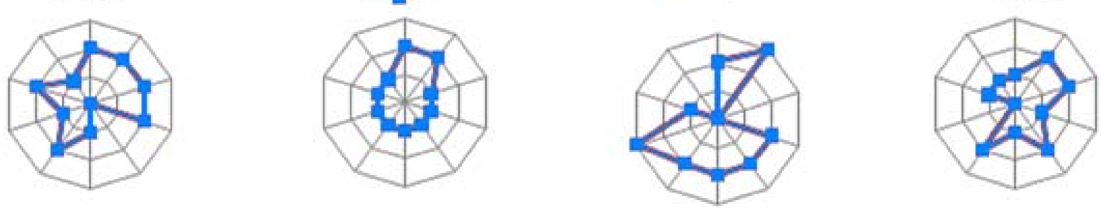
- Begun in May 2007 at Stevens Institute of Technology
- Sponsored by DoD Director of Systems and Software Engineering
- Three products planned:
  1. A modern reference curriculum for a master's degree in software engineering that integrates an appropriate amount of systems engineering
  2. A modern reference curriculum for a master's degree in systems engineering that integrates an appropriate amount of software engineering
  3. A truly interdisciplinary degree that is neither systems nor software engineering – it is both

1st Project – Graduate Software Engineering 2009

1. Understand the current state of SwE graduate education (November 2007)
2. Create GSwE2009 0.25 (formerly GSwERC) with a small team, suitable for limited review (February 2008)
3. Publicize effort through conferences, papers, website, etc (continuous)
4. Create GSwE2009 0.50 (formerly GSwERC) suitable for broad community review and early adoption (October 2008)
5. Create GSwE2009 1.0 suitable for broad adoption (2009)
6. Transition stewardship to professional societies (2009)
7. Foster adoption world-wide (2009 and beyond)

SWEBOK coverage* in 2007 across 28 SwE MS programs





*Coverage in required and semi-required courses

The curriculum author team

- Rick Adcock, Cranfield University and INCOSE representative, UK
- Edward Alef, General Motors, USA
- Bruce Amato, Department of Defense, USA
- Mark Ardis, Stevens Institute of Technology, USA
- Larry Bernstein, Stevens Institute of Technology, USA
- Barry Boehm, University of Southern California, USA
- Pierre Bourque, Ecole de Technologie Superieure and co-editor of 2010 SWEBOK update, Canada
- John Brackett, Boston University, USA
- Murray Cantor, IBM, USA
- Lillian Cassel, Villanova and ACM representative, USA
- Robert Edson, Analytic Services Inc., USA
- Richard Fairley, Colorado Technical University, USA
- Dennis Frailey, Raytheon and Southern Methodist University, USA
- Gary Hafen, Lockheed Martin and NDIA, USA
- Thomas Hilburn, Embry-Riddle Aeronautical University, USA
- Greg Hislop, Drexel University, and IEEE Computer Society representative, USA
- David Klappholz, Stevens Institute of Technology, USA
- Philippe Kruchten, University of British Columbia, Canada
- Phil Laplante, Pennsylvania State University, Great Valley, USA
- Qiaoyun (Liz) Li, Wuhan University, China
- Scott Lucero, Department of Defense, USA
- John McDermid, University of York, UK
- James McDonald, Monmouth University, USA
- Ernest McDuffie, National Coordination Office for NITRD, USA
- Bret Michael, Naval Postgraduate School, USA
- William Milam, Ford, USA
- Ken Nidiffer, Software Engineering Institute, USA
- Art Pyster, Stevens Institute of Technology, USA
- Paul Robitaille, Lockheed Martin, USA
- Mary Shaw, Carnegie Mellon University, USA
- Sarah Sheard, Third Millenium Systems, USA
- Robert Suritis, IBM, USA
- Massood Towhidnejad, Embry-Riddle Aeronautical University, USA
- Richard Thayer, California State University at Sacramento, USA
- J. Barrie Thompson, University of Sunderland, UK
- Guilherme Travassos, Brazilian Computer Society, Brazil
- Richard Turner, Stevens Institute of Technology, USA
- Joseph Urban, Texas Tech University, USA
- Ricardo Valerdi, MIT & INCOSE, USA
- David Weiss, Avaya, USA
- Mary Jane Willshire, Colorado Technical University, USA

Creating GSwE2009 0.25

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Publicize effort

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Publicize effort

1. Past and planned presentations and workshops at numerous conferences, including:
   – NDIA Systems Engineering Conferences 2007, 2008, and 2009; INCOSE International Symposium 2008 and 2009, ASEE 2008, Asian-Pacific INCOSE Conference 2008, SIGCSE 2008 and 2009, ICSE 2009, CSEET 2009, …
2. Short articles and announcements in SEWORLD, INCOSE Insight, …
3. Full article on survey of existing programs to appear in *IEEE Software* in fall 2009
4. Website at www.GSwE2009.org
5. Additional full articles in IEEE and ACM magazines planned

Creating GSwE2009 0.50 and 1.0

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Expectations at entry (from version 0.5+)

DEGREE:

The equivalent of an undergraduate degree in computing or an undergraduate degree in an engineering or scientific field and a minor in computing

SWE COURSE:

The equivalent of an introductory course in software engineering

EXPERIENCE:

At least two years of practical experience in some aspect of software engineering or software development

Outcomes at graduation (from Version 0.5+)

CBOK:

Master the Core Body of Knowledge

DOMAIN:

Be able to apply software engineering in at least one application domain, such as finance, medical, transportation, or telecommunications, and in one application type, such as real-time, embedded, safety-critical, or highly distributed systems. That ability to apply software engineering includes understanding how differences in domain and type manifest themselves in both the software itself and in their engineering, and includes understanding how to learn a new application domain or type.

DEPTH:

Have mastered at least one knowledge area or sub-area from the Core Body of Knowledge to at least the Bloom Synthesis level.

Outcomes at graduation

ETHICS:

Be able to make ethical professional decisions and practice ethical professional behavior.

SYSTEMS ENGINEERING:

Understand the relationship between software engineering and systems engineering and be able to apply systems engineering principles and practices in the engineering of software.

TEAM:

Be able to work effectively as part of a team, including teams that may be multinational and geographically distributed, to effectively communicate both orally and in writing, and to lead in one area of project development, such as project management, requirements analysis, architecture, construction, or quality assurance.

Outcomes at graduation

RECONCILIATION:

Be able to reconcile conflicting project objectives, finding acceptable compromises within limitations of cost, time, knowledge, risk, existing systems, and organizations.

PERSPECTIVE:

Understand and appreciate the importance of feasibility analysis, negotiation, effective work habits, leadership, and good communication with stakeholders in a typical software development environment.

LEARNING:

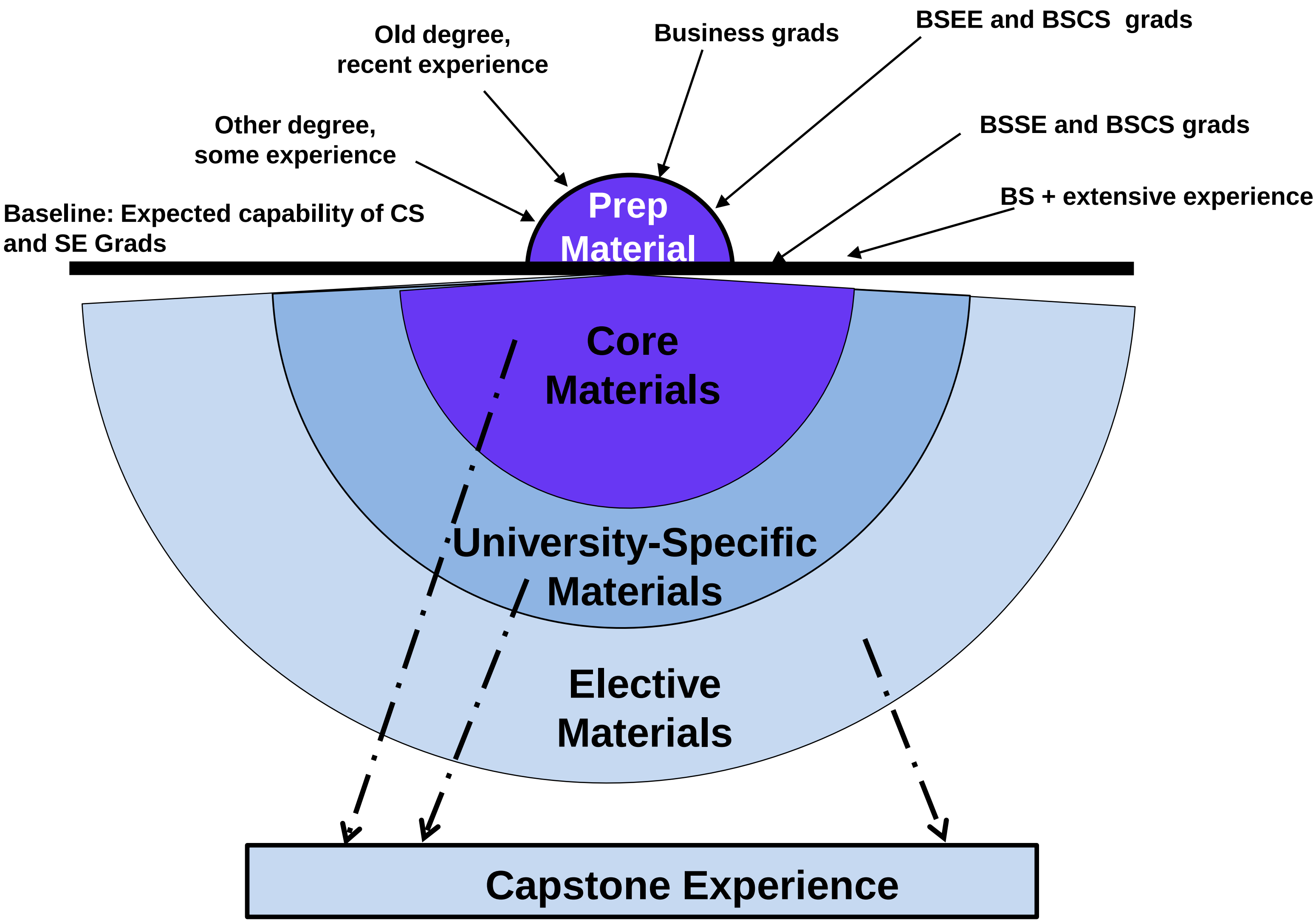
Be able to learn and apply new models, techniques, and technologies as they emerge, and appreciate the necessity of such continuing professional development.

Outcomes at graduation

TECHNOLOGY:

Be able to analyze a current significant software technology, articulate its strengths and weaknesses, compare it to alternative technologies, and specify and promote improvements or extensions to that technology.

Curriculum architecture



GSwE2009 Release

- Version 1.0 was released to the international SwE community Sept. 30, 2009.
  - Delivered to US DoD OSD
  - Delivered to ACM EB, IEEE CS, INCOSE, and CAT
  - The document is available online at www.gswe2009.org/curriclum/recommendations/document.pdf

Post-version 1.0 governance

1. Understand the current state of SWE graduate education (November 2007)
2. Create GSwE2009 0.25 with a small team, suitable for limited review (February 2008)
3. Publicize effort through conferences, papers, website, etc (continuous)
4. Create GSwE2009 0.50 suitable for broad community review and early adoption (October 2008)
5. Create GSwE2009 1.0 suitable for broad adoption (2009)
6. Transition stewardship to professional societies (2009)
7. Foster adoption world-wide (2009 and beyond)

Implementation help

- Comparison of existing graduate software engineering programs with GSwE2009 recommendations – know how big the gap is between recommendations and practice
- Strategies recommended by the authors to implement GSwE2009
- Hypothetical modifications of existing programs to more fully satisfy GSwE2009
- Workshops targeted to department heads and faculty
    - Build a business case for GSwE2009
    - Facilitate curriculum modification or development to align with GSwE2009 recommendations

Preparing for Post 1.0 World

- GSwE2009 v1.0—primary recommendations document—released Sept 30, 2009
- Two companion documents for GSwE2009 will be delivered October 2009:
  - Implementation guidance organized as an FAQ
  - Comparison of current SwE programs to GSwE2009
- Primary recommendations are typical of what professional societies traditionally shepherd
- Implementation guidance and comparisons are less typical of what professional societies traditionally shepherd

Possible long-term governance

- ACM, IEEE CS, INCOSE, NDIA SE, and the Brazilian Computer Society all participating in GSwE2009 creation.
- Joint ACM and IEEE CS (primary), and INCOSE (supportive) governance model for Curriculum Recommendations is desirable with periodic updates.
- Small volunteer body to provide periodic updates of FAQ and comparisons materials with website support including forums, wikis, and other open collaboration structure.
- Implementation workshops at conferences, summer faculty workshops, and other activities would promote adoption. The CAT is currently seeking assistance from the NSF to support these workshops.

- INCOSE sponsored a graduate systems engineering (SE) reference curriculum published in 2007.

- The SE curriculum development process did not have the scale of participation that GSwE2009 has and is limited by the fact that the INCOSE SE Body of Knowledge (see http://g2sebok.incose.org) is much less robust and mature than SWEBOK.

- INCOSE would like to mature the SE body of knowledge, which would be a strong foundation on which to base an upgraded SE curriculum.

- The U.S. Department of Defense is considering sponsoring a project to update and mature the SE body of knowledge with INCOSE and create a mature SE reference curriculum. The effort would be similar to GSwE2009 with open collaborative international participation and fully shared resulting intellectual property.

- Other professional societies would be welcome to participate.

Summary

- GSwE2009 v1.0 delivered September 30, 2009.
- Professional societies are considering taking ownership of the curriculum after it is published.
  - IEEE CS Educational Advisory Board voted to become sponsors of GSwE2009 October 2009
- GSwE2009 companion documents scheduled for release Fall 2009
- Adoption workshops anticipated summer 2010

Questions?

DoD Architecture and Standards Governance

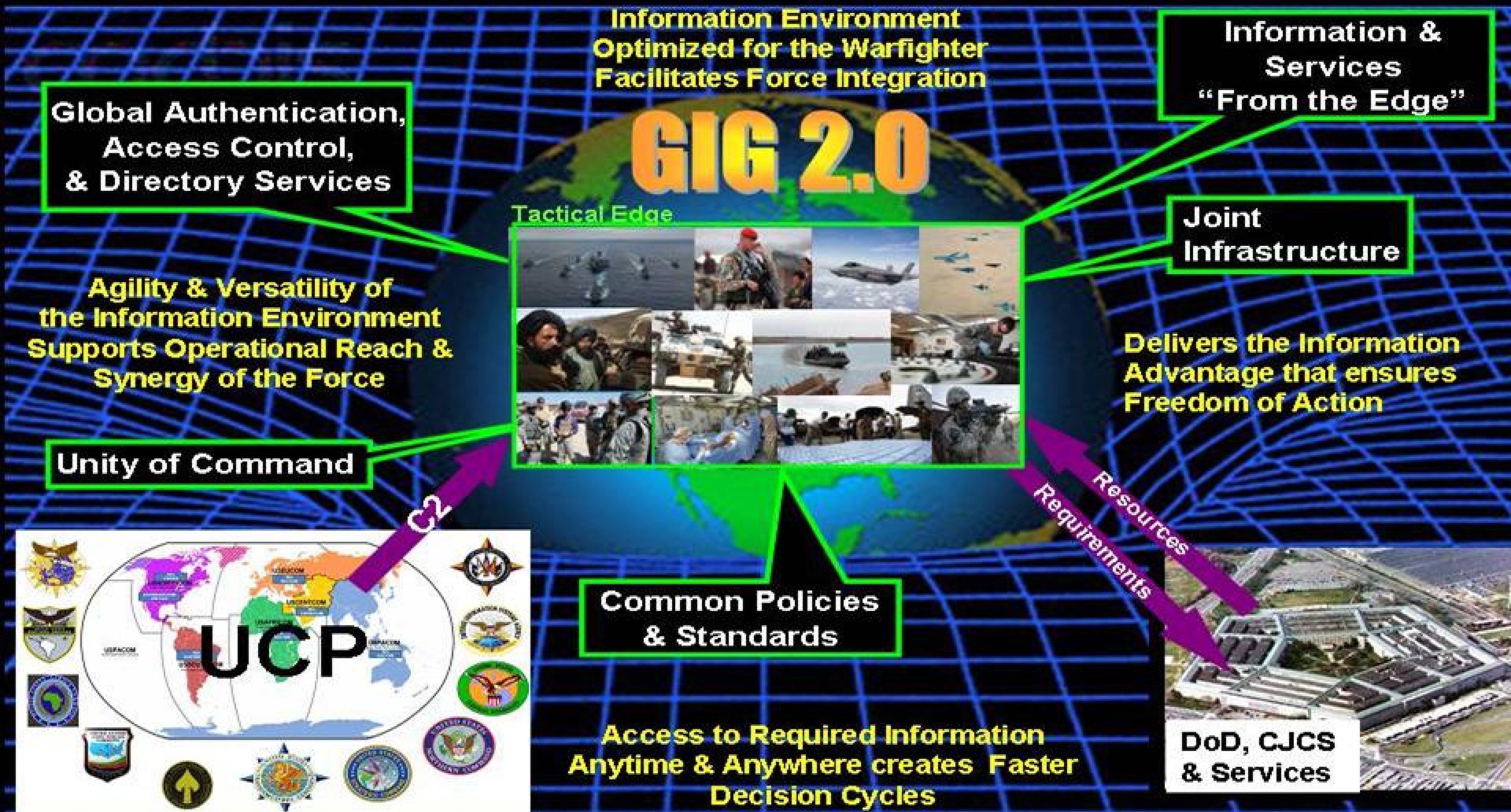
NDIA Systems Engineering Conference

John P. Skudlarek, CISSP

October 29, 2009

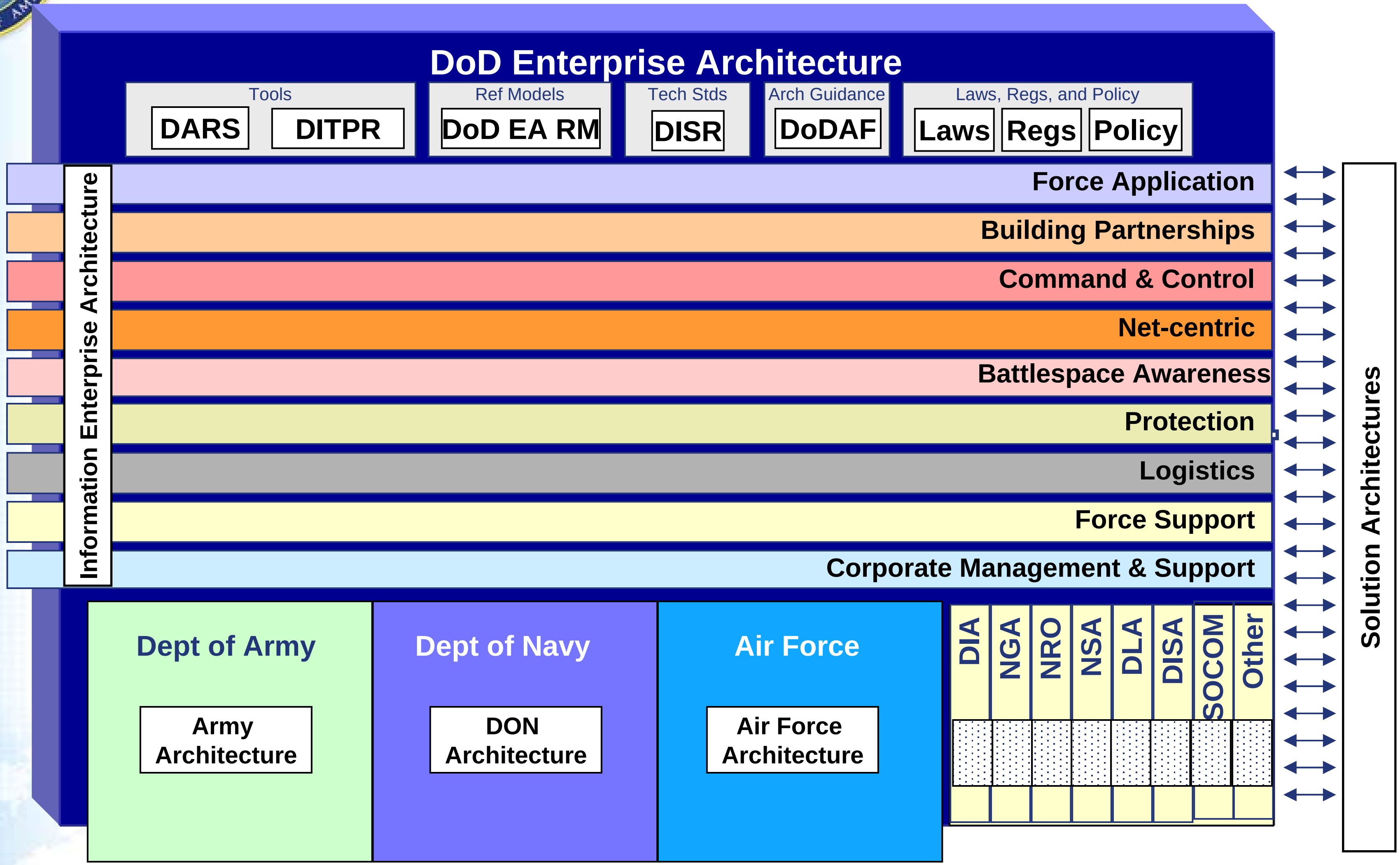
Enterprise Architecture & Standards Directorate
Office of the DoD Deputy Chief Information Officer

The GIG 2.0 High Level Operational Concept Graphic



Warfighter Focused

DoD Architecture Federation



DOD CIO Governance Restructure Memo- Signed 8/11/09

DEPARTMENT OF DEFENSE
6000 DEFENSE PENTAGON
WASHINGTON, DC 20301-6000

CHIEF INFORMATION OFFICER

AUG 11 2009

MEMORANDUM FOR CHAIRMAN OF THE JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
GENERAL COUNSEL OF THE DEPARTMENT OF DEFENSE
DIRECTOR, ADMINISTRATION AND MANAGEMENT
DIRECTOR, PROGRAM ANALYSIS AND EVALUATION
DIRECTORS OF THE DEFENSE AGENCIES
CHIEF INFORMATION OFFICER, U.S. STRATEGIC COMMAND
CHIEF INFORMATION OFFICER, U.S. JOINT FORCES COMMAND
DIRECTOR OF NATIONAL INTELLIGENCE CHIEF INFORMATION OFFICER
CHIEF INFORMATION OFFICERS OF THE MILITARY DEPARTMENTS

SUBJECT: DoD CIO Governance Board Restructure Implementation

With the support of your staffs, this office has completed an effort to streamline the DoD Information Management/Information Technology governance structure to reduce duplicative or unneeded governing bodies, and to leverage tiered accountability and delegate authority wherever possible. The attached document provides this new structure, composed of forums within the authorities of the DoD Chief Information Officer (CIO) via DoD Directive 5144.01. This new structure provides for better oversight of the development, review and endorsement of initiatives; empowerment of lower forums; and strengthening of the decision-making and advisory processes between and among the DoD CIO and the DoD CIO community.

Implementation of this new governance structure is effective immediately. Points of contact are Ellen Law (ellen.law@osd.mil; 703-699-0118) and Ron Alsbrooks (Ronald.alsbrooks.ctr@osd.mil; 703-699-0101).

David M. Wennergren
Performing the Duties of the
ASD(NII)/ DoD CIO

Attachment:
CIO Governance Board Restructure

DEPARTMENT OF DEFENSE
CHIEF INFORMATION OFFICER

Deputy Assistant Secretary of Defense for Information Management, Integration, and Technology

MR. DAVID WENNERGREN

- EXECUTIVE ASSISTANT
- COMMAND OPS & OUTREACH
- STRATEGIC ADVISOR

Special Assistant for Net-Centric Operations

- NET-CENTRIC EDUCATION (JPME)
- JCTDS
- SAG

Federal Information Sharing Executive

- FEDERAL INFORMATION SHARING INITIATIVE
- INFORMATION SHARING STRATEGY / IMPLEMENTATION PLAN
- CUI

DIRECTORS

CIO Management Services

- PROGRAM ANALYSIS & SUPPORT
- CIO GOVERNANCE
- INFORMATION QUALITY
- DOMAIN NAME & WEB POLICY
- PRIVACY IMPACT ASSESSMENTS
- E-GOVERNMENT (OMB)
- RESOURCE MANAGEMENT
- SECTION 508
- IT WORKFORCE
- ACADEMIA OUTREACH
- OMB LIAISON
- GAO LIAISON
- CONGRESSIONAL LIAISON
- CIO ROLE – 8000.01
- FORMS MGMT
- INFO COLLECTION
- WEB ADMIN/MGMT

Enterprise Services Integration

- RECORDS MGMT
- DATA STRATEGY / COIs
- SERVICES STRATEGY / SOA
- NCES, MCEITS, CANES
- IDENTITY MGMT. & ATTRIBUTE SERVICES
- SPECIAL ASST TO THE VCJCS
- CLOUD COMPUTING
- WEB 2.0 – DoD Use
- DOD APPS STORE

Strategic Planning & Policy

- STRATEGIC PLAN
- PERFORMANCE MEASUREMENT
- POLICY FRAMEWORK
- FUTURE OF THE CIO
- INTERNET GOVERNANCE
- AGENCY/ASSOC. OUTREACH
- FEA LIAISON

Commercial Technologies & Systems

- TITLE 40 / CCA OVERSIGHT
- CPI / LSS
- INDUSTRY OUTREACH CLEARINGHOUSE
- ACQUISITION SUPPORT
- COTS TECH REVIEW & MARKET RESEARCH
- INFORMATION SUPPORT PLANS
- ENTERPRISE SYSTEMS HEALTH CARE, ERPs, DIMHRS, etc.
- INTEROPERABILITY

Portfolio Management & Enterprise Infrastructure

- ENTERPRISE SOFTWARE INITIATIVE
- IT ASSET MANAGEMENT & COMMODITY BUYING
- IT INVESTMENT MANAGEMENT
- ENTERPRISE GUIDANCE BOARD
- DoD IT INFRASTRUCTURE LIBRARY (ITIL)
- COMPUTING INFRASTRUCTURE
- DITPR
- DBSMC – BTA/IRB LIAIASON
- NGEN OVERSIGHT
- JOINT BASING
- CPM COORDINATION

Enterprise Operations

- NETOPS
- IPv6
- UNIFIED CAPABILITIES
- ENTERPRISE OPERATIONS & OVERSIGHT COMMITTEE
- OSD CIO LIAISON
- PACC
- RISK MANAGEMENT
- GIG WAIVERS/CONNECTION APPROVAL PROCESS

Enterprise Architecture & Standards

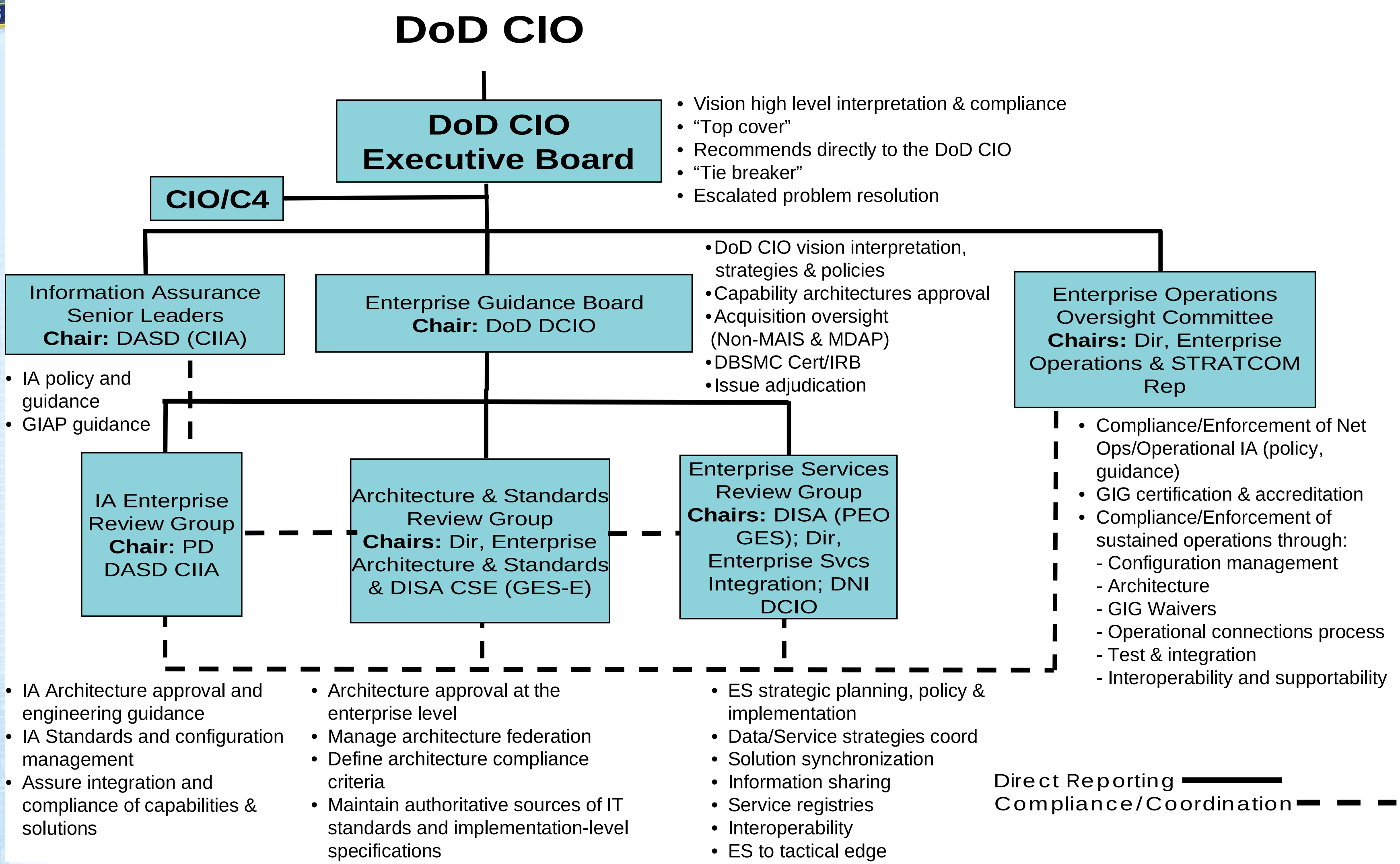
- DOD FEDERATED ENT. ARCH
- STANDARDS (DISR)
- DoD INFO ENT ARCH 2.0
- DADAF 2.0
- DARS
- REFERENCE ARCH SUPPORT

*

Creating an Information Advantage

JULY 2009

CIO Governance Framework



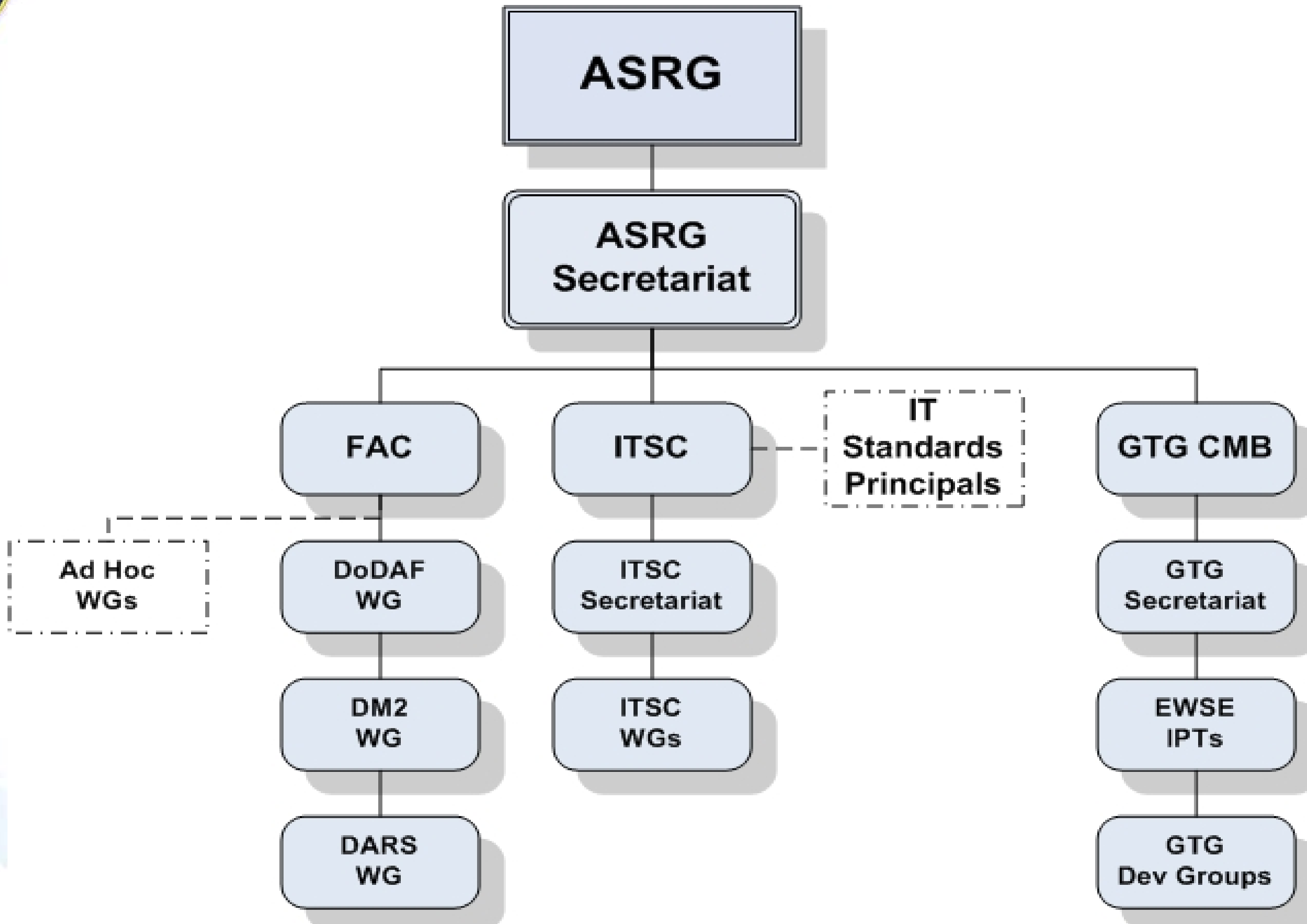
DEPARTMENT OF DEFENSE
CHIEF INFORMATION OFFICER

Creating an Information Advantage

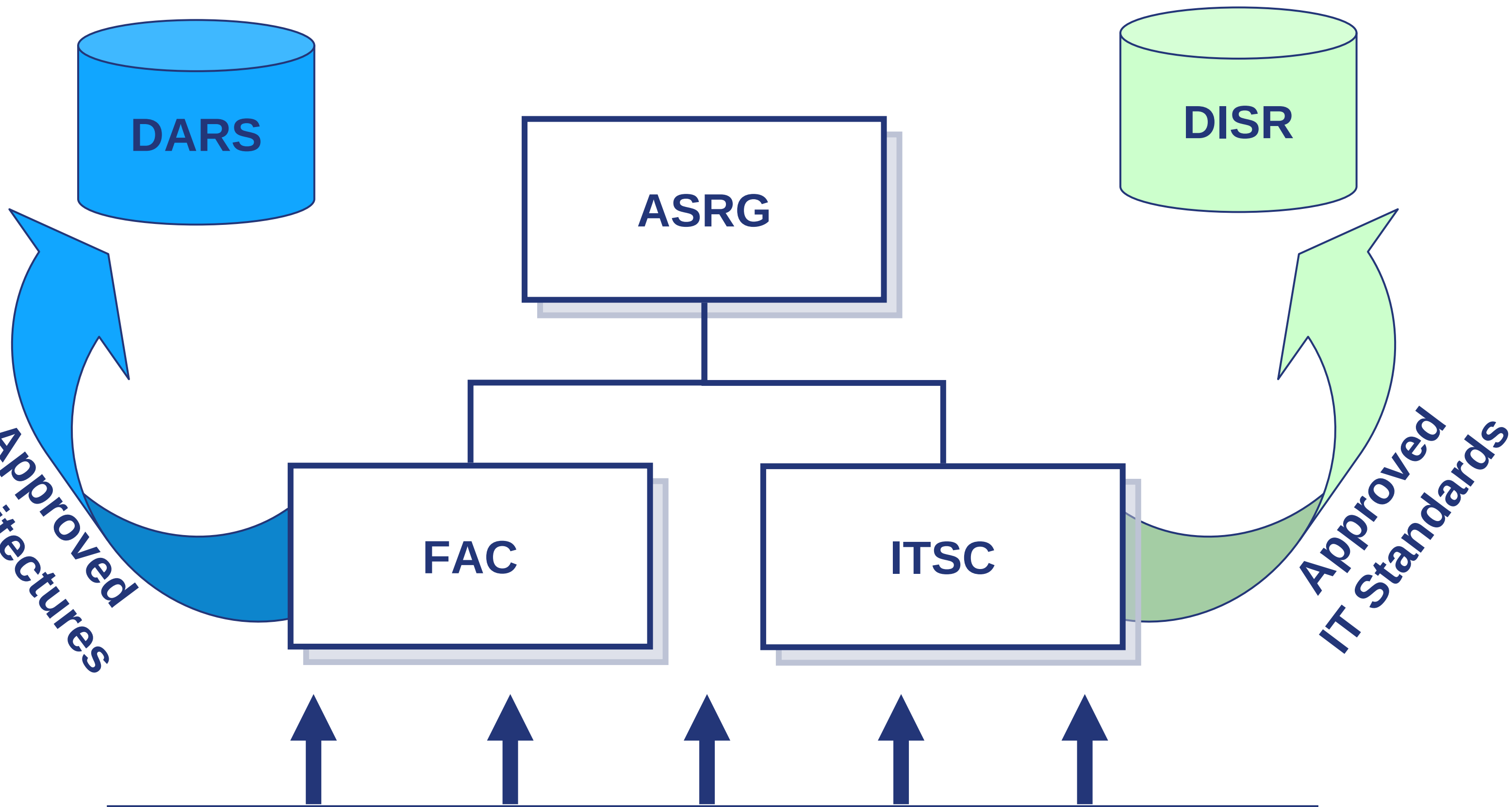
ASRG Mission

The Architecture and Standards Review Group (ASRG) serves within the Department of Defense (DoD) Chief Information Officer (CIO) Enterprise Governance framework. The ASRG is subordinate to the DOD CIO EGB. It is chartered to: review architecture policy and guidance; identify DoD Information technology (IT) technical standards; oversee IT standards management; review architectures and enforce architecture policy; oversee DoD EA Federation; and enforce DoD Information Enterprise Architecture (IEA) compliance.

ASRG Organizational Structure



Authoritative Sources of Approved Architectures & Standards



<u>DoD Policy</u>
DoDD 5000, DoDD 4630, DoDD 8210,
CJCSI 6212, CJCSI 3170

https://dars1.army.mil/IER2/

DoD Architecture Registry System

Contact Help

Member LogIn

User ID (Forgot?)

https://dars1.army.mil/IER2/

Password (Forgot?)

Login

CAC Login

No Account? Sign Up

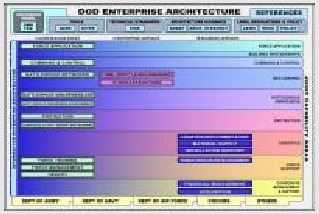
News & Events

8/18/2009
DoDAF 2.0 Meta-model (DM2) Walkthrough (Details)

9/1/2009 - 9/2/2009
DARS user group attendees, please see attached lunch order form (Details)

9/1/2009
DARS User Group Agenda (Details)

Welcome



DARS provides for registration and cataloging of DoD Architectures

DARS Enables:

- Overview and Summary (AV-1) registration, creation and editing
- Discovery metadata creation and search
- Alignment with federation reference models
- Visualization of the federated Enterprise Architecture (EA)
- Access-controlled data storage
- Architecture data management

Quick Links

- General Public Documents
- EA Conference Briefs
- Manage Communities & Users
- Change Request Form
- Tutorials

UNCLASSIFIED/FOUO

The Department of Defense DoD Privacy Policy

https://disronline.disa.mil/

DEPARTMENT OF DEFENSE
CHIEF INFORMATION OFFICER

DISRonline DoD Information Technology Standards Registry
UNCLASSIFIED

FAQs
DISR Calendar
Reports & Archives

DISRonline Home | Contacts | Guidance | Links | Change User Info | Register CAC | Create RFC | Problems? | Need Help? | Log Off

Standards Mgmt

- Profiling
- Search
- Classic Search
- Change Request
- Standards Management
  - ISOP
  - ITSC
  - Working Groups
  - SDO / NATO
- Configuration Management
- DISA Home

DISRonline will be offline beginning Thursday, 22 October, through the following week.

ITSC

Information Technology Standards Committee (POCs)

- Charter *(Signed)*
- Standard Operating Procedures (SOP) - ITSC/ISC/TWG *2009-07-28*

ITSC Briefing Templates

- TWG Briefing Template (2008-02-20)

ITSC Meeting 2009 10 21

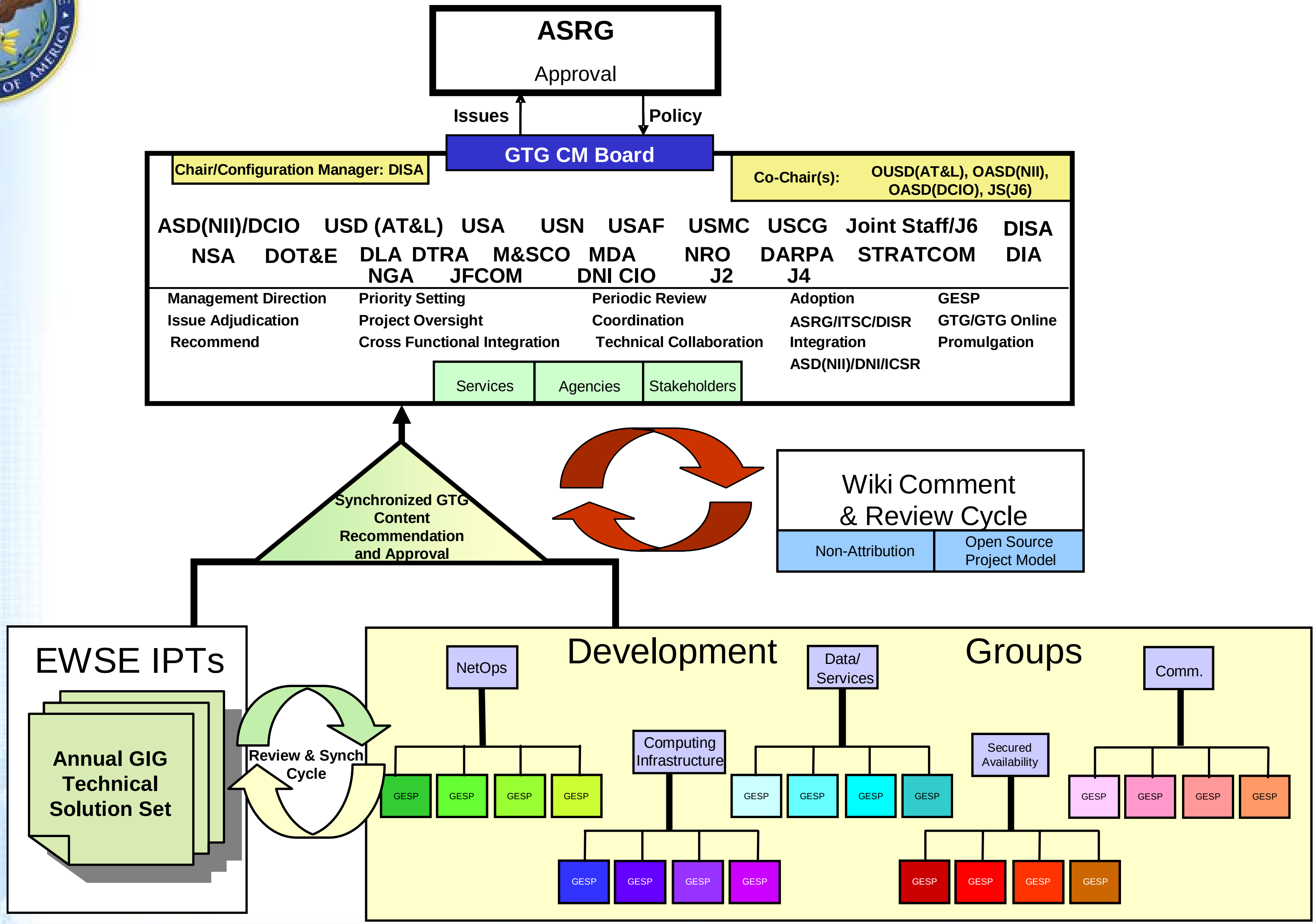
- Agenda / Minutes
  - Agenda
  - ITSC Open Action Items (2009-10-07)
- Briefings
  - Decision Brief - DISR and DISRonline Topics (D Bernardini)
  - Information Brief - "Data Standards" Management for the DISR - (D Brown)
  - Information Brief - Update on M&S Technical Working Group - (A Henninger)
  - Information Brief - IC/DoD Enterprise Standards Governance (J Makowka)
  - Information Brief - ICESG Pilot 09-3.0 (C Guthrie, M Pettit)
  - Information Brief - Architecture & Standards Review Group (ASRG) Briefing (A Golombek)
  - Information Brief - Net-Centric Operations Industry Consortium (NCOIC) Briefing (D Brown)

ITSC Meeting 2009 06 24

- Agenda / Minutes
  - Agenda
  - ITSC Open Action Items (2009-07-02)
  - Meeting Minutes (2009-06-24)
- Briefings
  - Decision Brief - DISR and DISRonline Topics (D Bernardini)

UNCLASSIFIED/FOUO

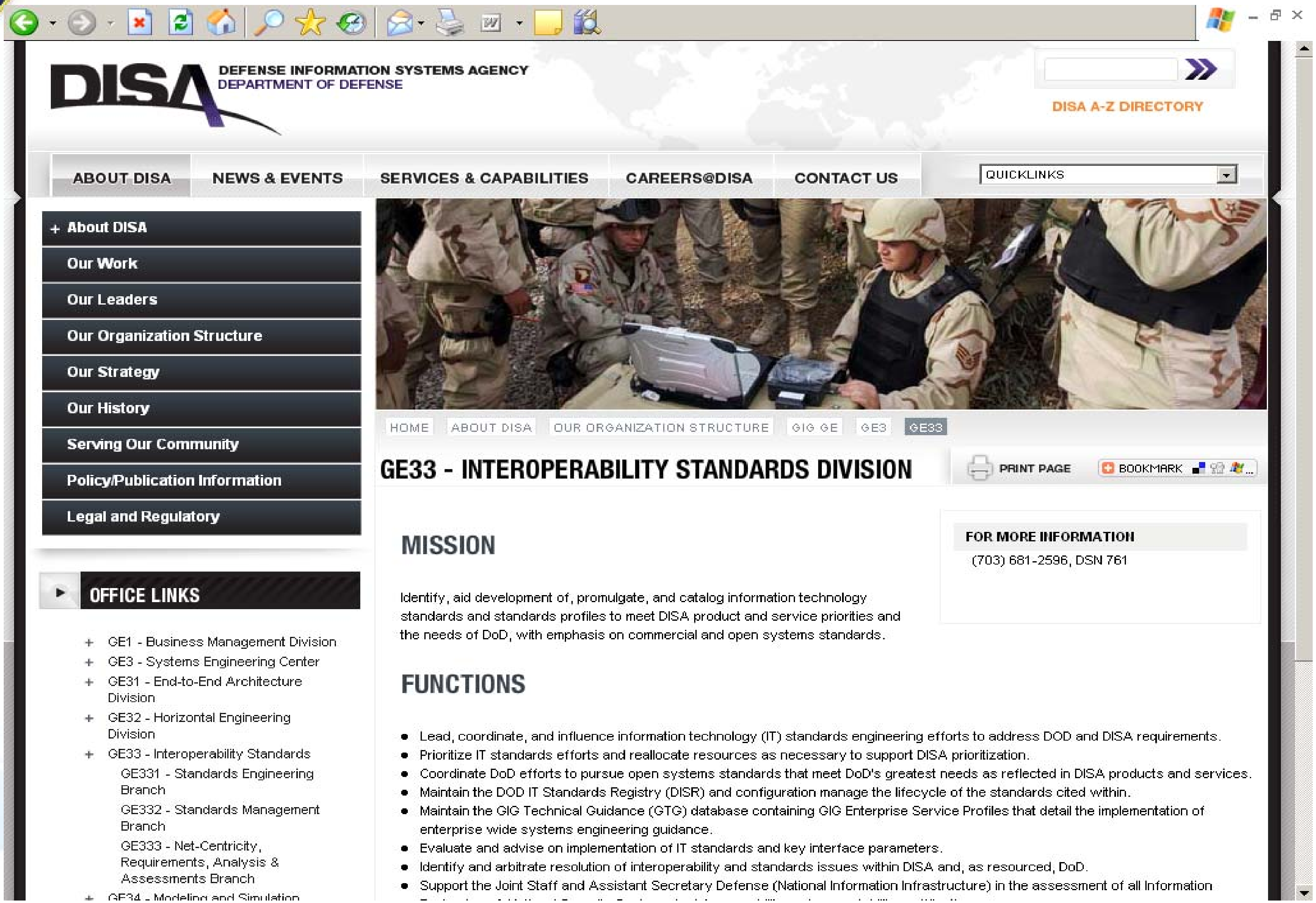
GTG CMB Governance Structure



DEPARTMENT OF DEFENSE CHIEF INFORMATION OFFICER

Creating an Information Advantage

http//www.disa.mil/ge/ge3/ge33.html



DISA DEFENSE INFORMATION SYSTEMS AGENCY
DEPARTMENT OF DEFENSE

DISA A-Z DIRECTORY

ABOUT DISA | NEWS & EVENTS | SERVICES & CAPABILITIES | CAREERS@DISA | CONTACT US

QUICKLINKS

+ About DISA
- Our Work
- Our Leaders
- Our Organization Structure
- Our Strategy
- Our History
- Serving Our Community
- Policy/Publication Information
- Legal and Regulatory

OFFICE LINKS

- GE1 - Business Management Division
- GE3 - Systems Engineering Center
- GE31 - End-to-End Architecture Division
- GE32 - Horizontal Engineering Division
- GE33 - Interoperability Standards
  - GE331 - Standards Engineering Branch
  - GE332 - Standards Management Branch
  - GE333 - Net-Centricity, Requirements, Analysis & Assessments Branch
- GE34 - Modeling and Simulation

HOME | ABOUT DISA | OUR ORGANIZATION STRUCTURE | GIG GE | GE3 | GE33

GE33 - INTEROPERABILITY STANDARDS DIVISION

PRINT PAGE | BOOKMARK

FOR MORE INFORMATION
(703) 681-2596, DSN 761

MISSION

Identify, aid development of, promulgate, and catalog information technology standards and standards profiles to meet DISA product and service priorities and the needs of DoD, with emphasis on commercial and open systems standards.

FUNCTIONS

- Lead, coordinate, and influence information technology (IT) standards engineering efforts to address DOD and DISA requirements.
- Prioritize IT standards efforts and reallocate resources as necessary to support DISA prioritization.
- Coordinate DoD efforts to pursue open systems standards that meet DoD's greatest needs as reflected in DISA products and services.
- Maintain the DOD IT Standards Registry (DISR) and configuration manage the lifecycle of the standards cited within.
- Maintain the GIG Technical Guidance (GTG) database containing GIG Enterprise Service Profiles that detail the implementation of enterprise wide systems engineering guidance.
- Evaluate and advise on implementation of IT standards and key interface parameters.
- Identify and arbitrate resolution of interoperability and standards issues within DISA and, as resourced, DoD.
- Support the Joint Staff and Assistant Secretary Defense (National Information Infrastructure) in the assessment of all Information

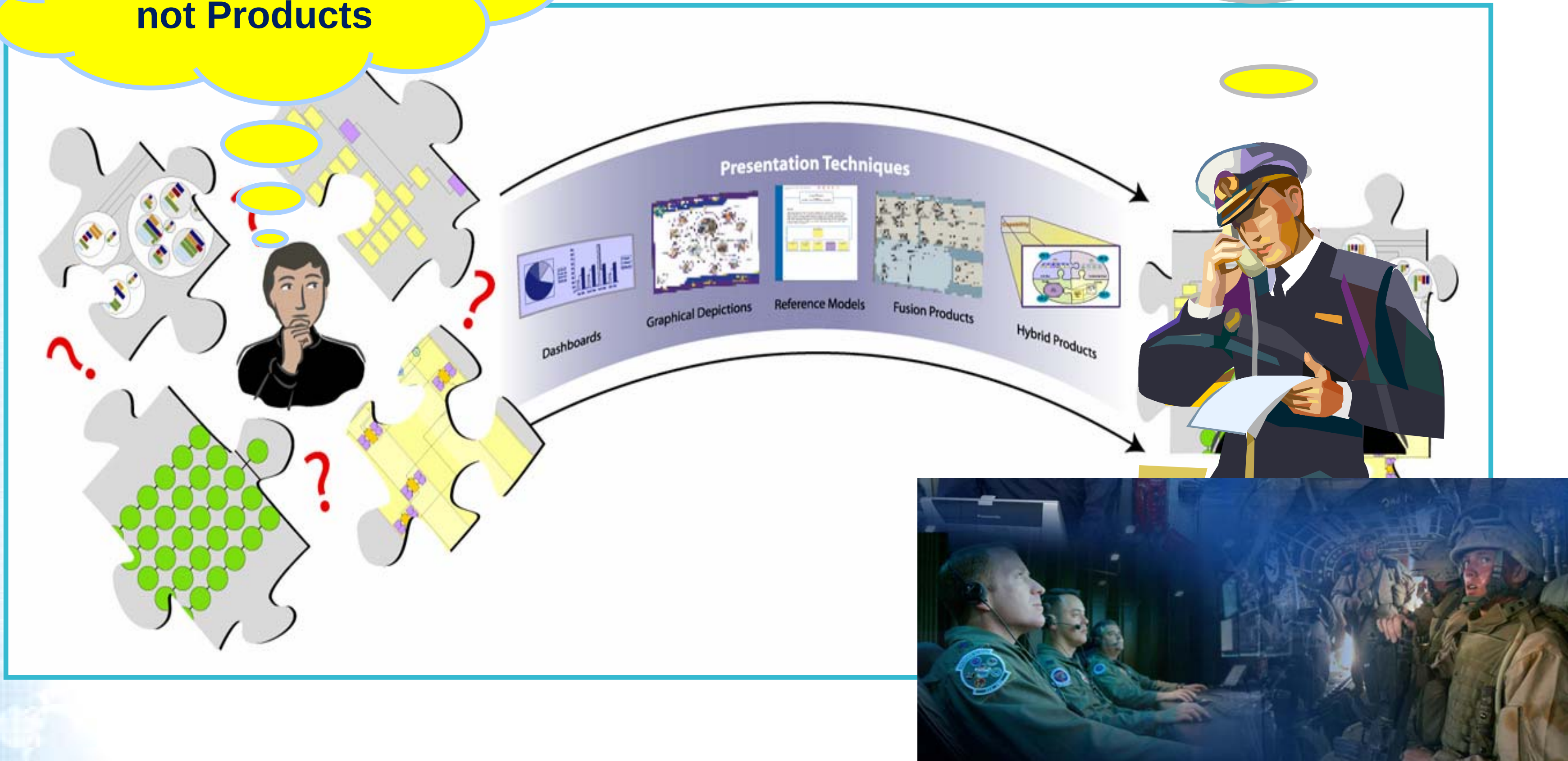
DEPARTMENT OF DEFENSE
CHIEF INFORMATION OFFICER

Creating an Information Advantage

DoDAF V2.0 Focus

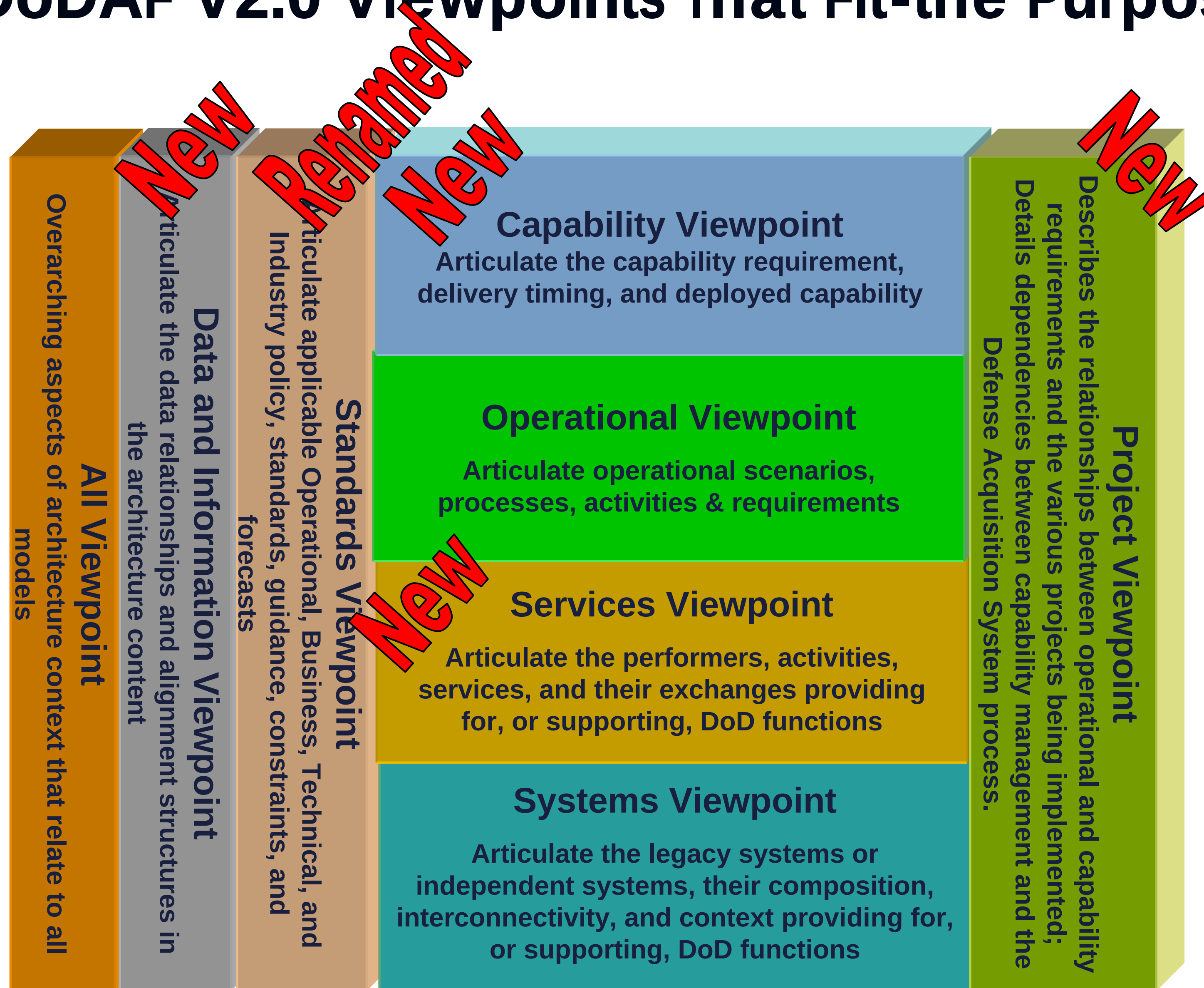
Focus: architecture DATA, not Products

Results: Better ANALYSIS and Decisions.



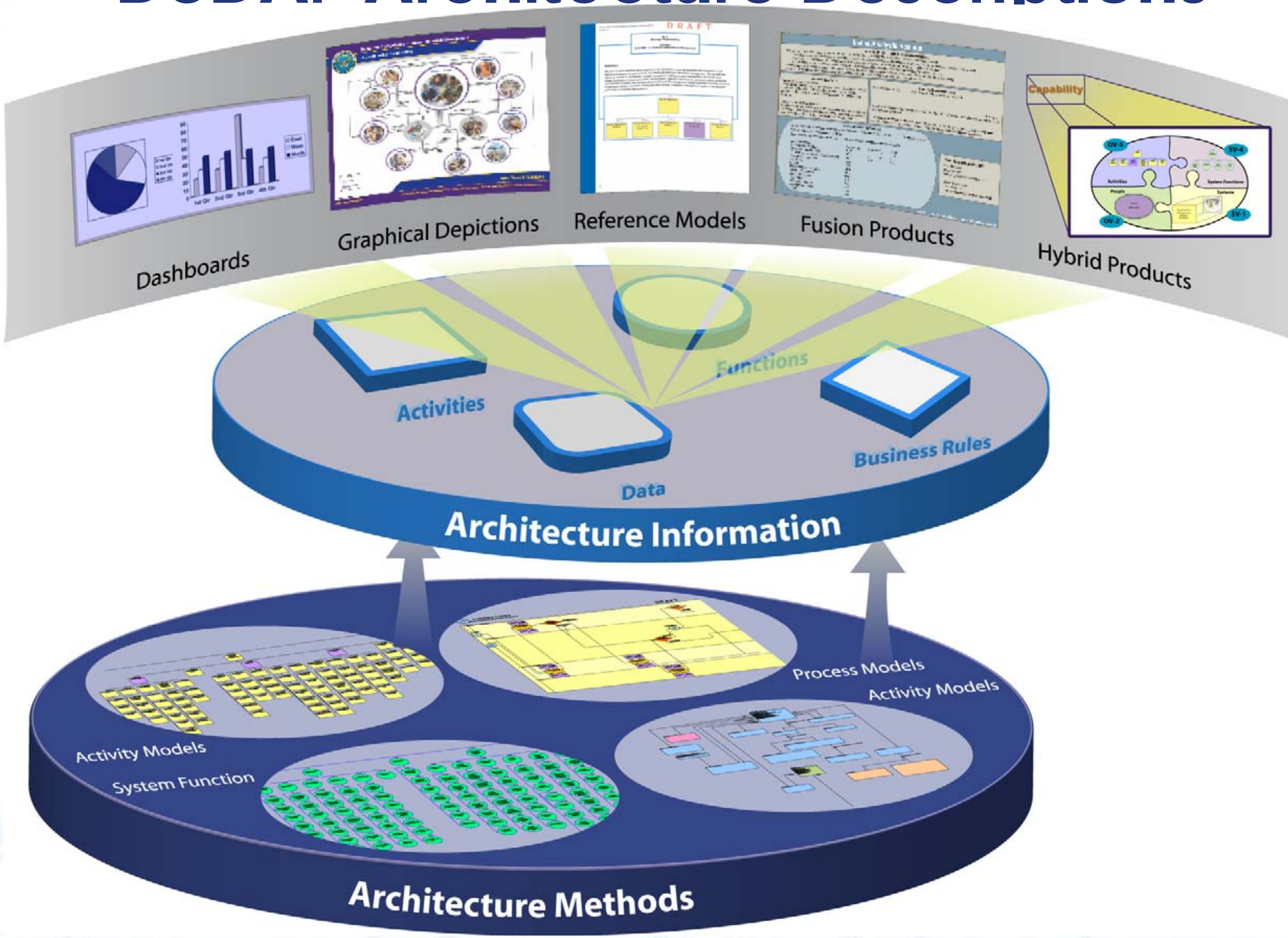
DoDAF V2.0 provides overarching architecture concepts, guidance, best practices, and methods to enable and facilitate architecture development.

DoDAF V2.0 Viewpoints That Fit-the Purpose



Architecture viewpoints are composed of data that has been organized to facilitate understanding.

"Fit for Purpose" DoDAF Architecture Descriptions



DoDAF V 2.0 Delivery

- **DoDAF V2.0 is available at:**
- **https://www.us.army.mil/suite/page/454707**
- **http://www.defenselink.mil/**
- **http://www.defenselink.mil/cio-nii/docs/DoDAF%20V2%20-%20Volume%201.pdf**

http://www.defenselink.mil/cio-nii/sites/diea/

Defense Information Enterprise Architecture

April 11, 2008 | DIEA Mission | DIEA Priorites | Contact Us

DIEA 1.0 Products

- **DIEA Architecture Description (OV-1)**
- Project Charter (AV-1)
- Hierarchical Activity Model (OV-5)
- Principles and Rules (OV-6a)
- Glossary (AV-2)
- ----------------------
- FAQs

Net-Centric Guidance

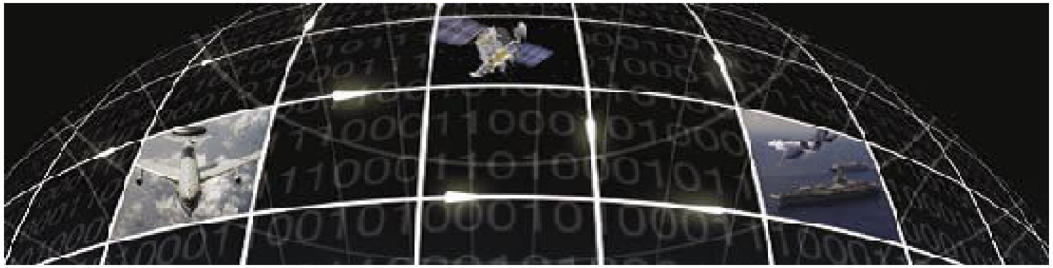
- DoD CIO Homepage
- DoD CIO Strategic Plan
- DoD Net-Centric Data Strategy
- DoD Net-Centric Services Strategy
- DoD Information Assurance Policy
- DoD Information Sharing Strategy
- DoD IT Portfolio Management Directive
- DoD Telecommunications Directive

Transition Partners

- Defense Business Transformation

Privacy and Web Policies

"Lead the DoD Enterprise to Achieve an Information Advantage for our People and Mission Partners"



Defense Information Enterprise Architecture Release

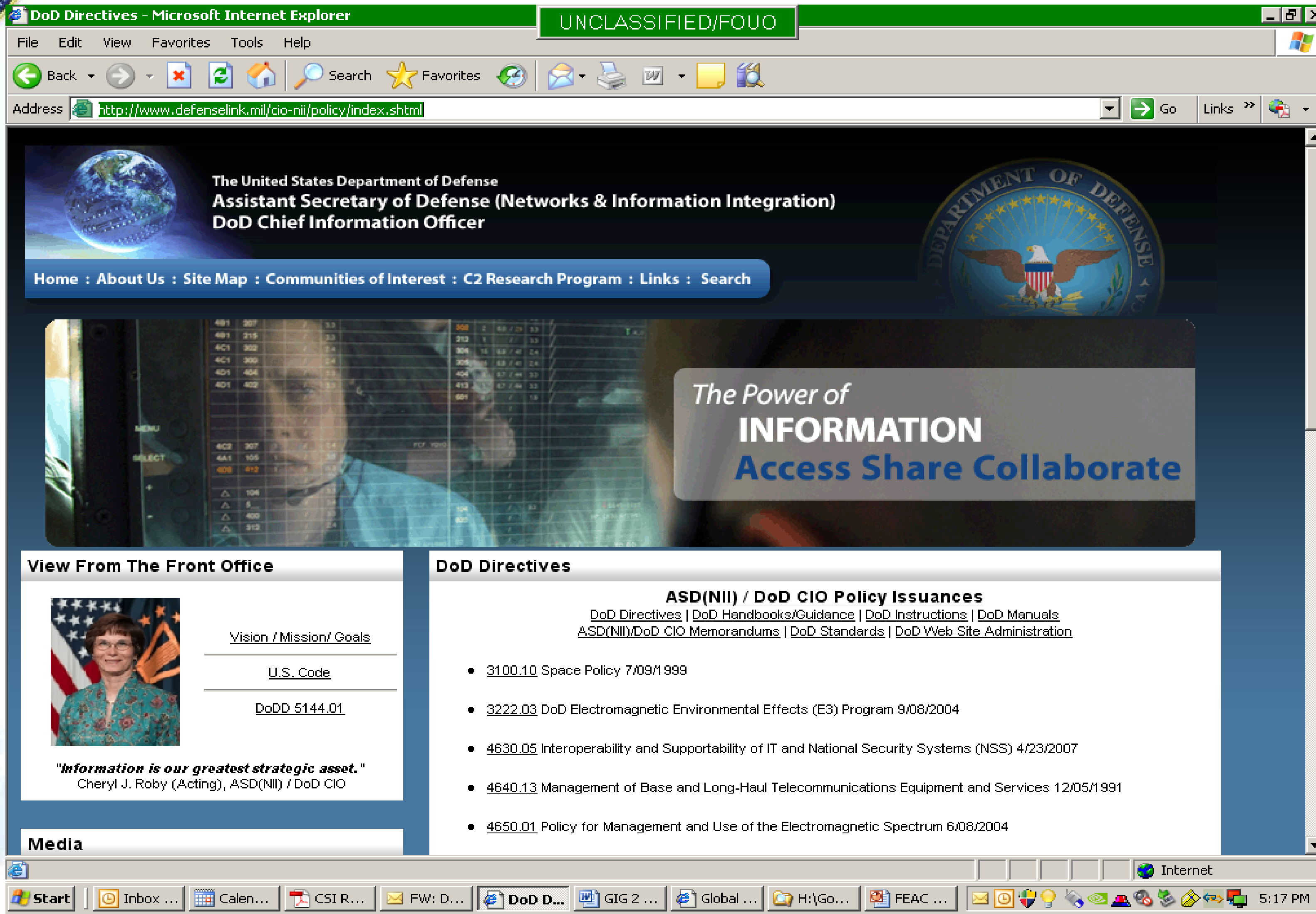
The Defense Information Enterprise Architecture version 1.0 (DIEA 1.0) provides a common Defense Information Enterprise foundation to support accelerated Department of Defense (DoD) transformation to net-centric operations. It presents the vision of net-centric operations and establishes near term priorities to address critical barriers that must be overcome in order to achieve the vision.

The Defense Information Enterprise Architecture consolidates underlying DoD Net-Centric policies to provide guidance for all DoD, across all portfolios, enabling informed discussions among decision-makers about key issues, and underpinning process improvements throughout the Department. Defense Information Enterprise Architecture 1.0 highlights the key principles, rules, constraints and best practices to which applicable DoD programs, regardless of Component or portfolio, must adhere in order to enable agile, collaborative net-centric operations.

Defense Information Enterprise Architecture Products

This website represents the main method for distributing Defense Information Enterprise Architecture 1.0. The full set of Defense Information Enterprise Architecture 1.0 products are available from the left side menu entitled "DIEA 1.0 Products" where users can access:

http://www.defenselink.mil/cio-nii/policy/index.shtml



DEPARTMENT OF DEFENSE
CHIEF INFORMATION OFFICER

May 10-14, 2010

DoD Enterprise Architecture Conference 2010, San Antonio, TX

Save the date!

Systems Engineering Needs of the DoD Architecture Framework

Report of the

Architecture Frameworks Working Group
Systems Engineering Division
National Defense Industrial Association

Co-Leads

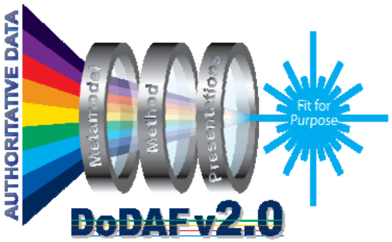
Carl Siel, ASN-RDA CHSENG

Joe Kuncel, Northrop Grumman

AFWG Purpose and Products

Purpose

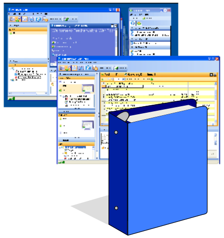
- Recommend changes and additions to the DOD Architecture Framework (DoDAF) and related standards that will improve support for DOD systems engineering, development, and acquisition.



Products

Final report and briefing of

- Analysis of DoDAF satisfaction of SE needs
- Conclusions
- Recommendations for improvement



AFWG Members

Name	Organization
Carl Siel (Co-Leader*)	US Navy Chief Systems Engineer, ASN-RDA-CHSENG
Joe Kuncel (Co-Leader)	Northrop Grumman
Ajit Narayan	Northrop Grumman
Chris Phelps	Sumaria
Cliff Whitcomb	US Naval Post Graduate School
David Putman	BAE Systems
Diane Hanf	Mitre Corp.
Elizabeth Luvender	Mitre Corp.
Hal Wilson	Northrop Grumman
Jennifer Rainey	Johns Hopkins University-Advanced Physics Laboratory
John Palmer	Boeing
Kristin Giammarco	US Army AMC & US Naval Post Graduate School
Robert Curry	Raytheon
Scott Osborne	Savvee Consulting, Inc.
Thomas Murphy	Silver Bullet Solutions, Inc.

* AFWG founder and sponsor

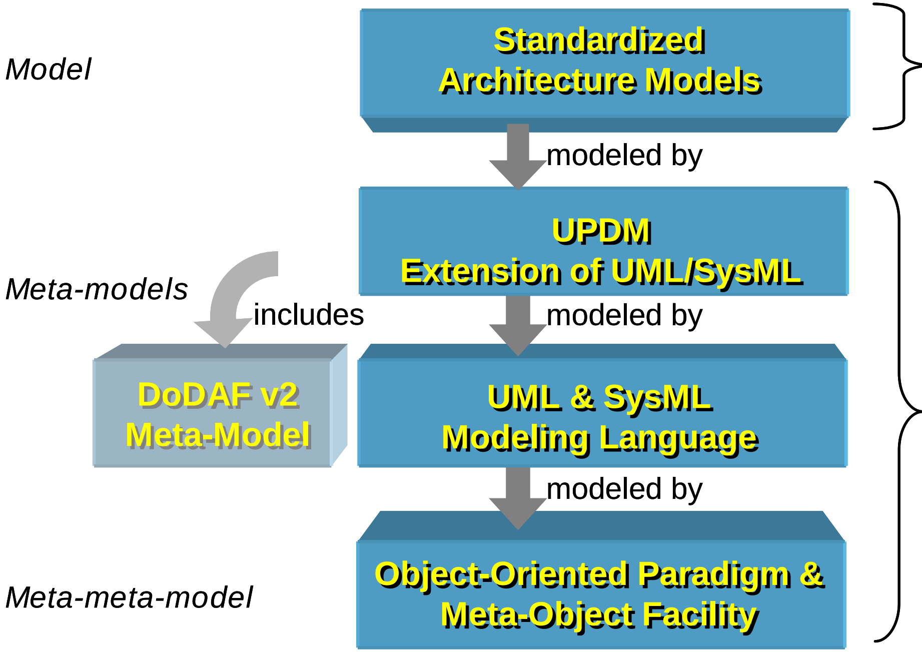
SE Needs of DoDAF

- **SE Needs**
  - Standard architecture modeling methodology
    for greater reuse/sharing, more efficient/standardized modeling
  - Greater definition and standardization of architecture elements
    incorporation of Services' "architecture elements lists"
  - Executable/simulatable architecture models
    for early and inexpensive architecture verification and validation
  - Composable/decomposable architectures
    for multiple levels of abstraction for hierarchy of stakeholders
  - More reusable architecture models
    faster, more efficient, more standard architecture development
  - Standard architecture alternatives analysis method
    for continuous architecture improvement
  - Standard architecture modeling notation and symbology
    better architecture comprehension and communication
  - Auto-generation of systems engineering artifacts
    lowering costs by leveraging architecture model's "authoritative data"

Recommendations

Standard architecture modeling methodology

- Object-Oriented, UML, SysML, UPDM implementation of DM2



Greater Model..

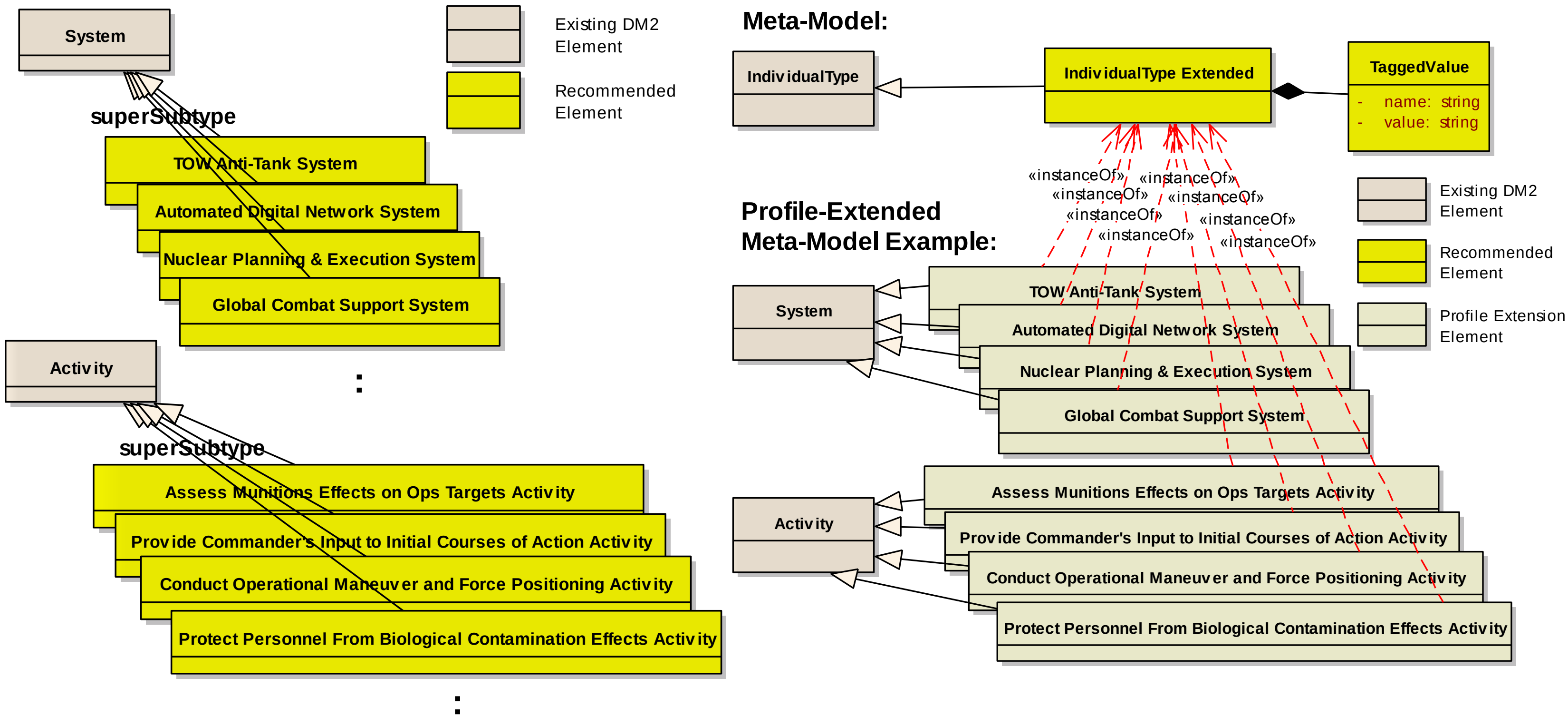
- **Reuse & Sharing**
- **Communication**
- **Comprehension**
- **Precision**

- **Mature Industry Standards**
- **Broadest Tool Support**
- **Widest Skills Base**
- **Most Academic Support**
- **Most Intuitive**
- **Greatest Model…**
  - **Scalability**
  - **Flexibility**
  - **Adaptability**

Recommendations

Greater definition, standardization of architecture elements

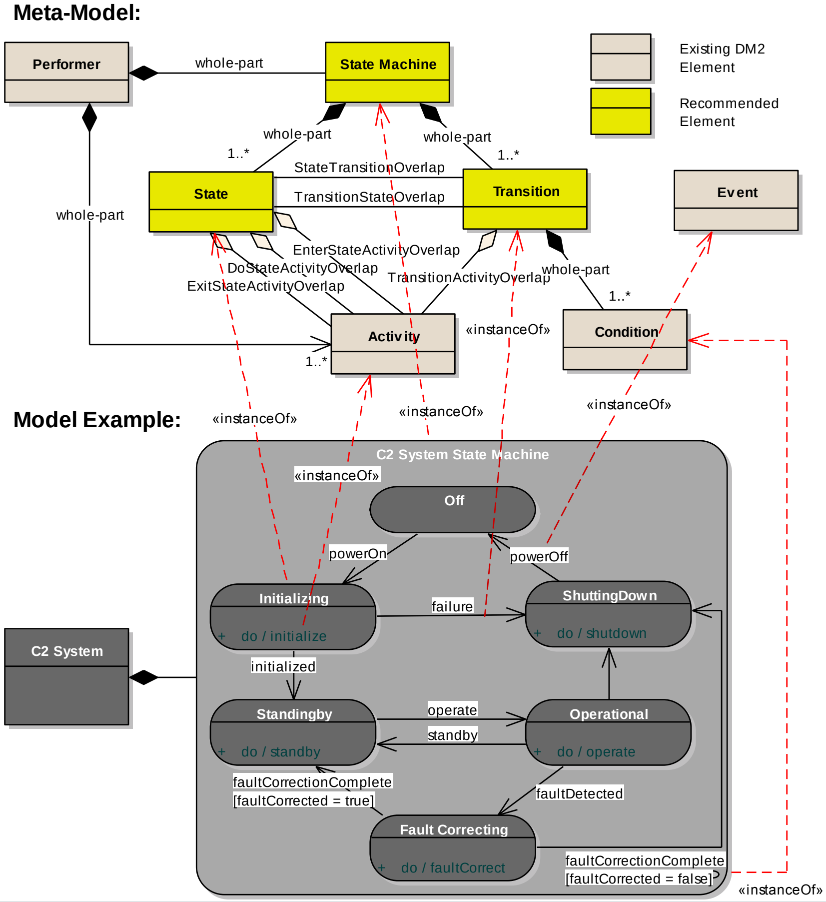
- Integrate JFCOM's standard architecture elements into the DM2
  - by adding elements to meta-model OR
  - by enabling user extension (profile) of meta-model



Recommendations

Executable/simulatable architecture models

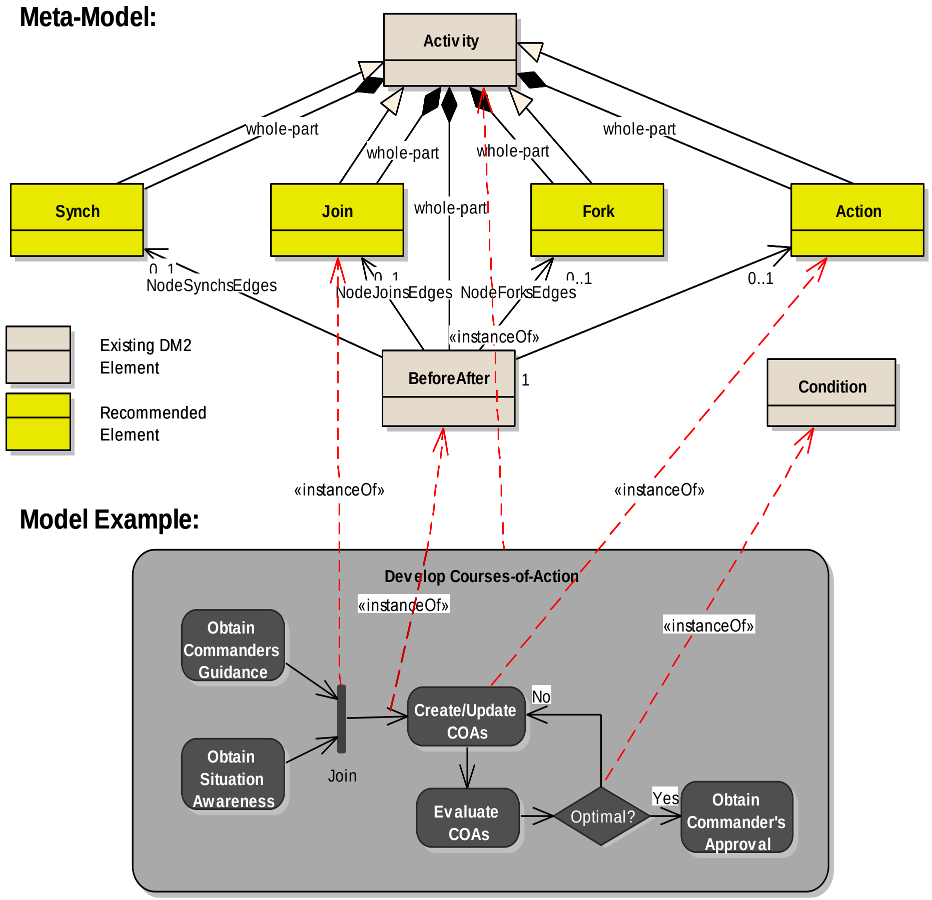
- Add behavioral semantics for state-machine …



Recommendations

Executable/simulatable architecture models (cont'd)

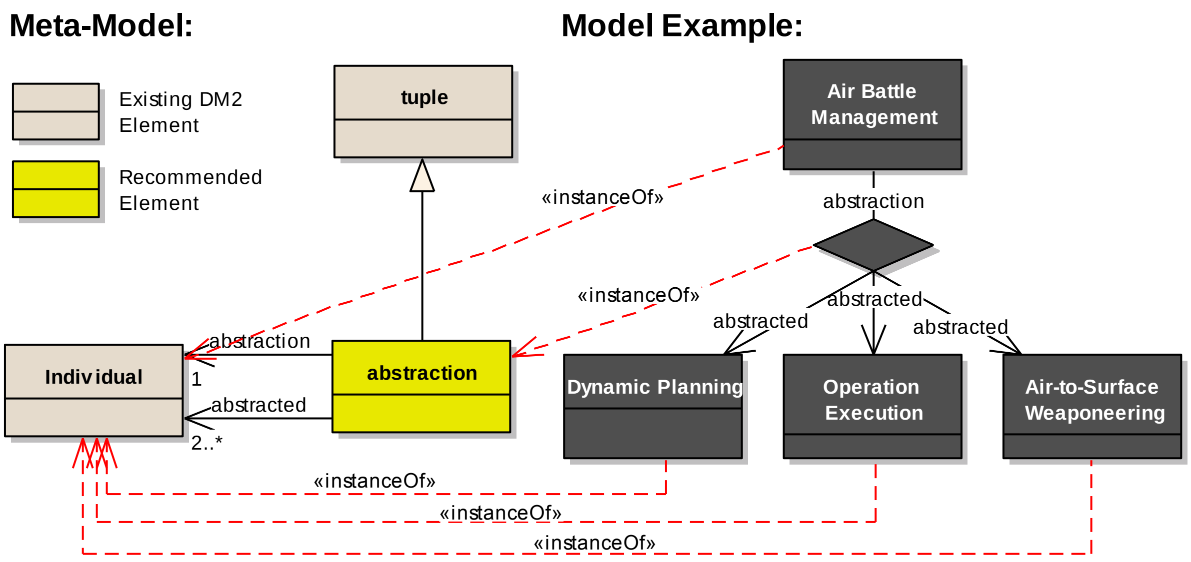
- And add behavioral semantics for activity definition …



Recommendations

Composable/decomposable architectures

- Add abstraction relationship…

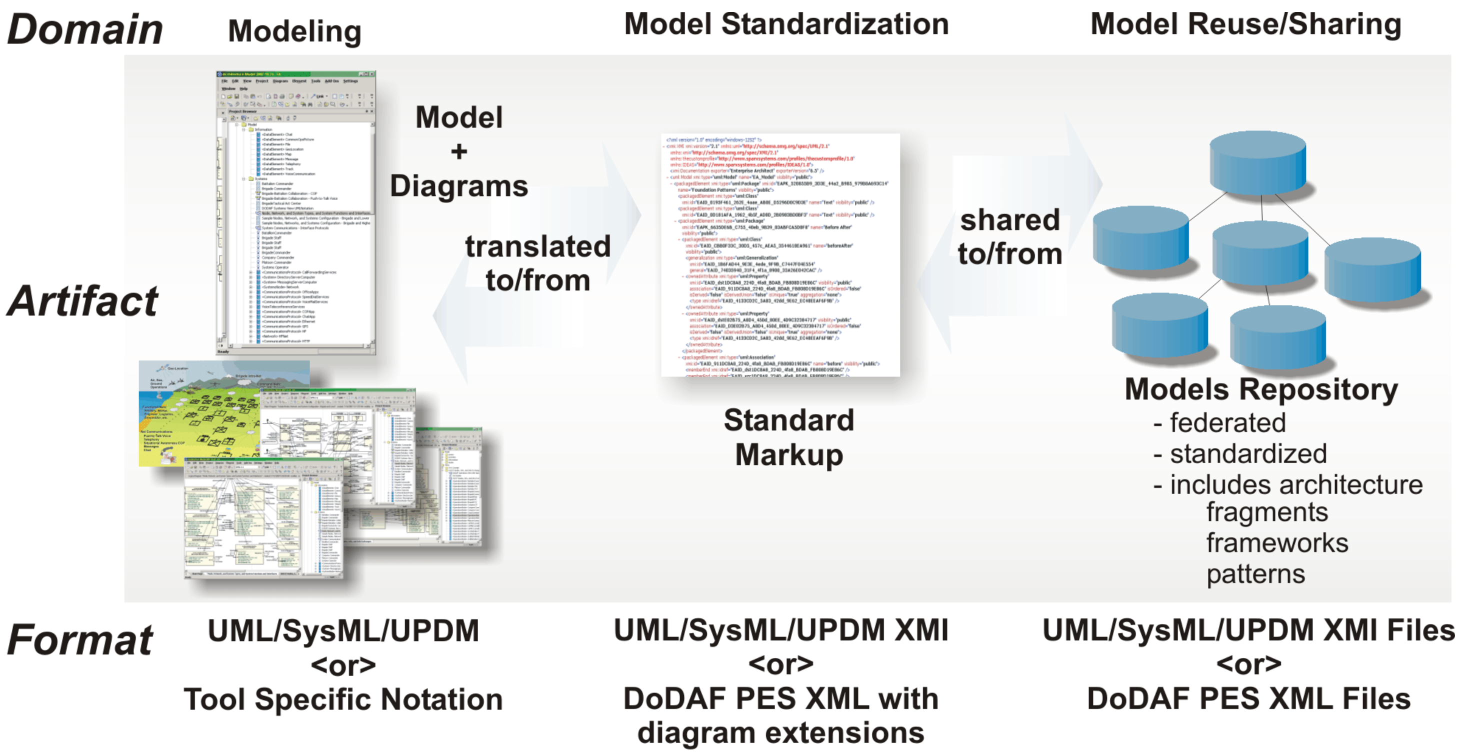


Note: DM2 deemed to satisfy need for structural composition/decomposition of architectures

Recommendations

More reusable architecture models

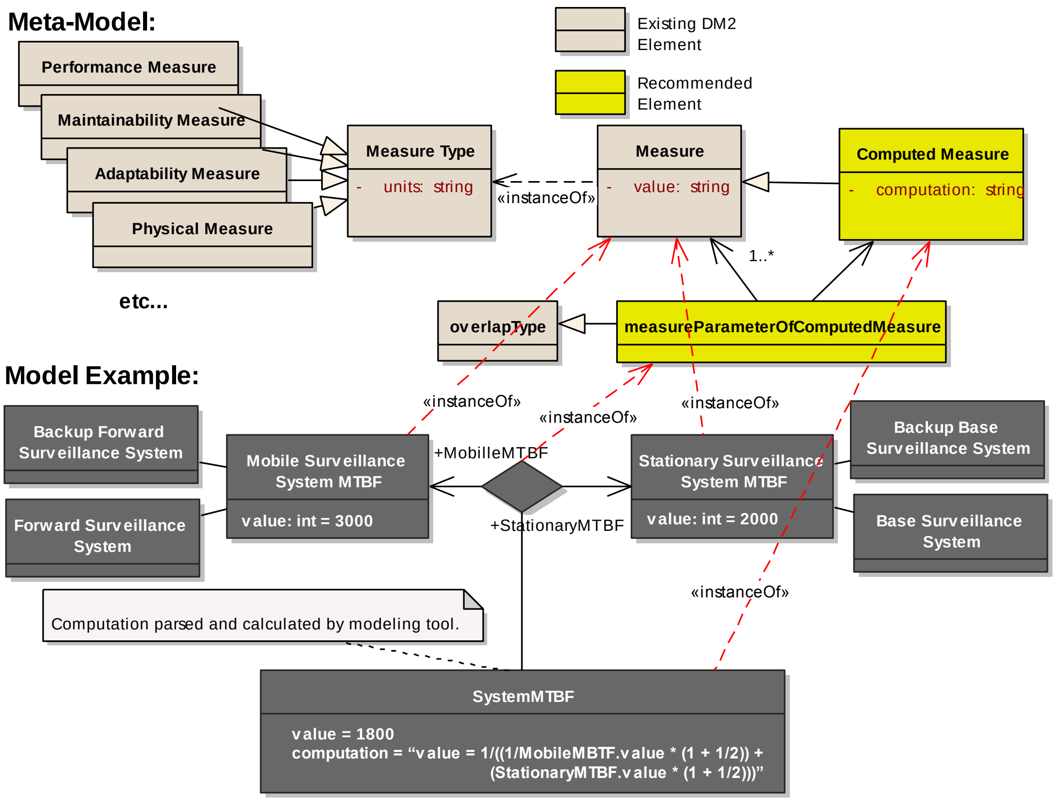
- Extend physical exchange standard (PES) to include diagrams exchange (XMI for UPDM already includes diagram exchange)
- Standardize DARS on PES (prefer XMI)
- Add patterns and frameworks support to DARS



Recommendations

Standard architecture alternatives analysis method

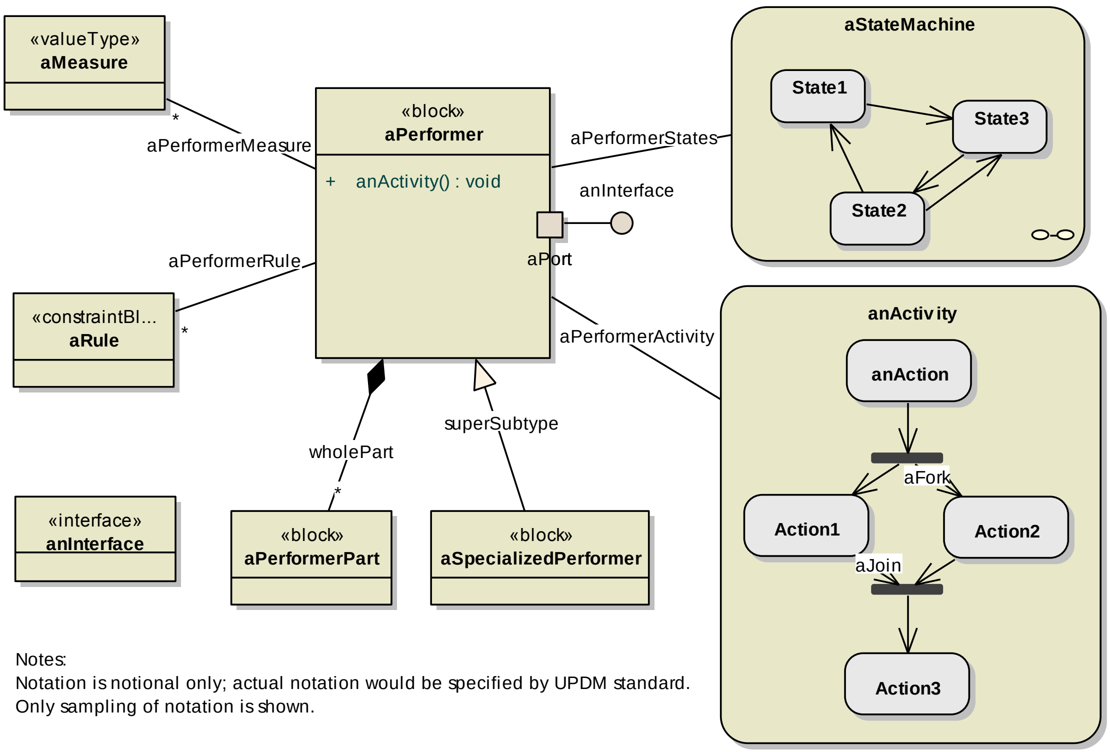
- Extend meta-model with parametric analysis semantics
- Standardize on SEI's Systems and Software ATAM



Recommendations

Standard architecture modeling notation and symbology

- Establish UML/SysML/UPDM as standard notation …

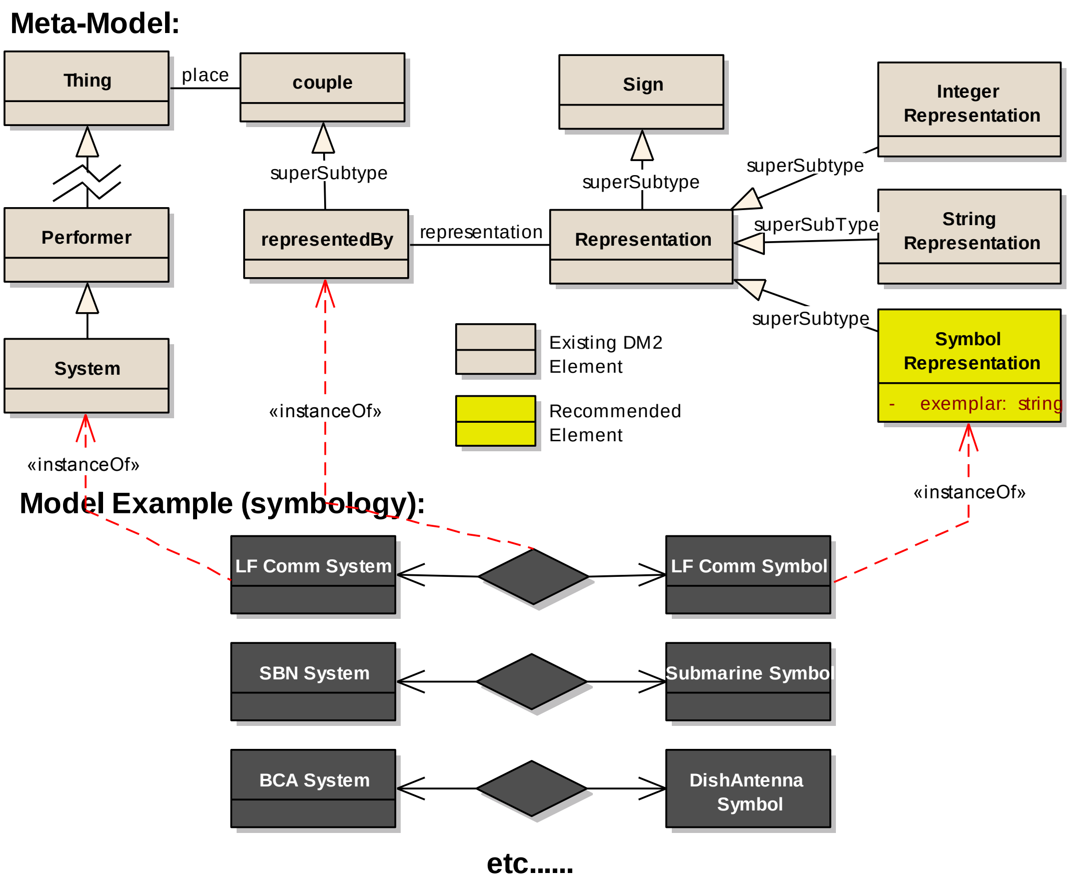


Notes:
Notation is notional only; actual notation would be specified by UPDM standard.
Only sampling of notation is shown.

Recommendations

Standard architecture modeling notation and symbology

- Extend meta-model with symbolic representation semantics ….

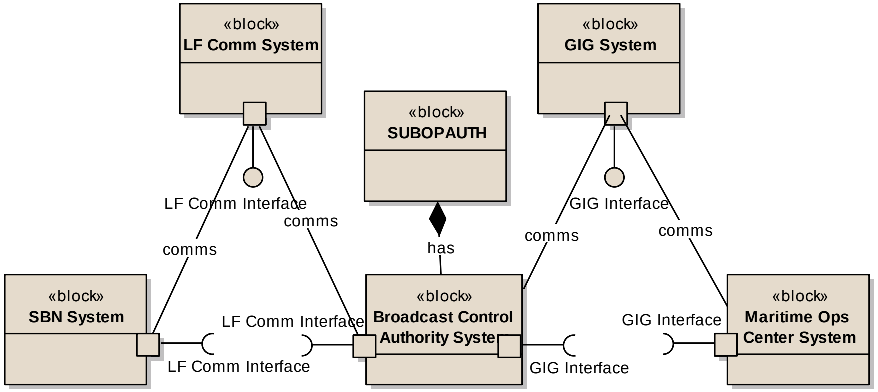


Recommendations

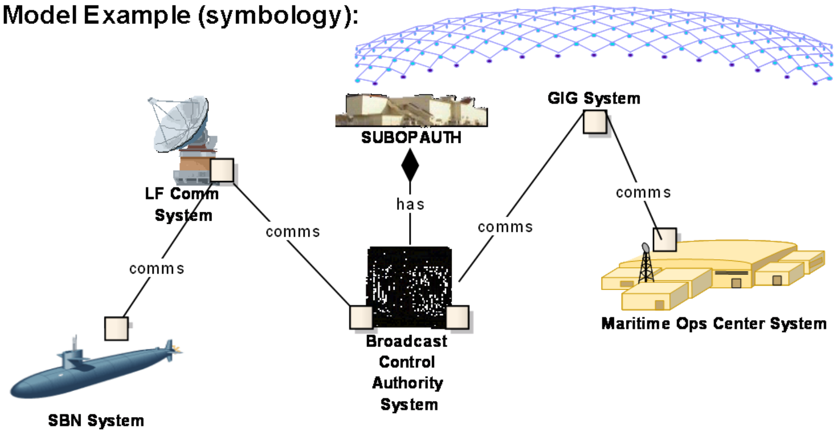
Standard architecture modeling notation and symbology

- Establish DoD Metadata Registry-like standard symbology library

Model Example (notation):



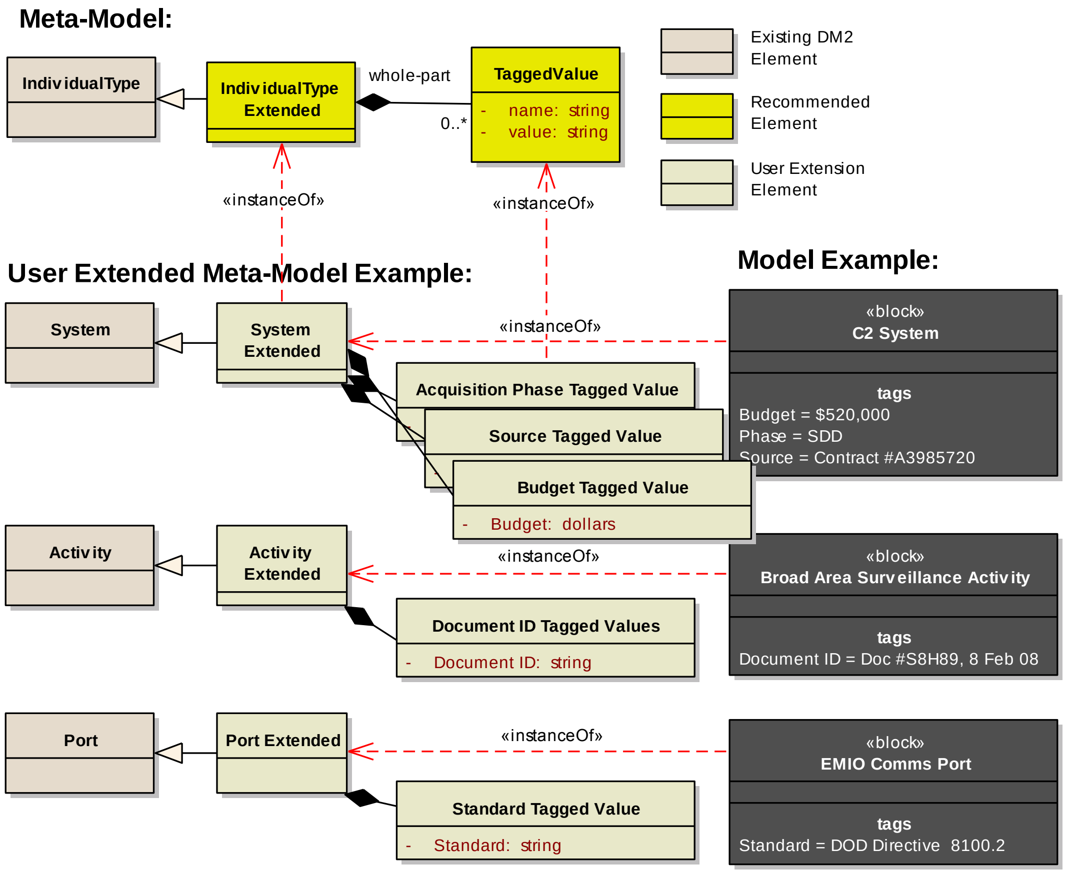
Model Example (symbology):



Recommendations

Auto-generation of systems engineering artifacts

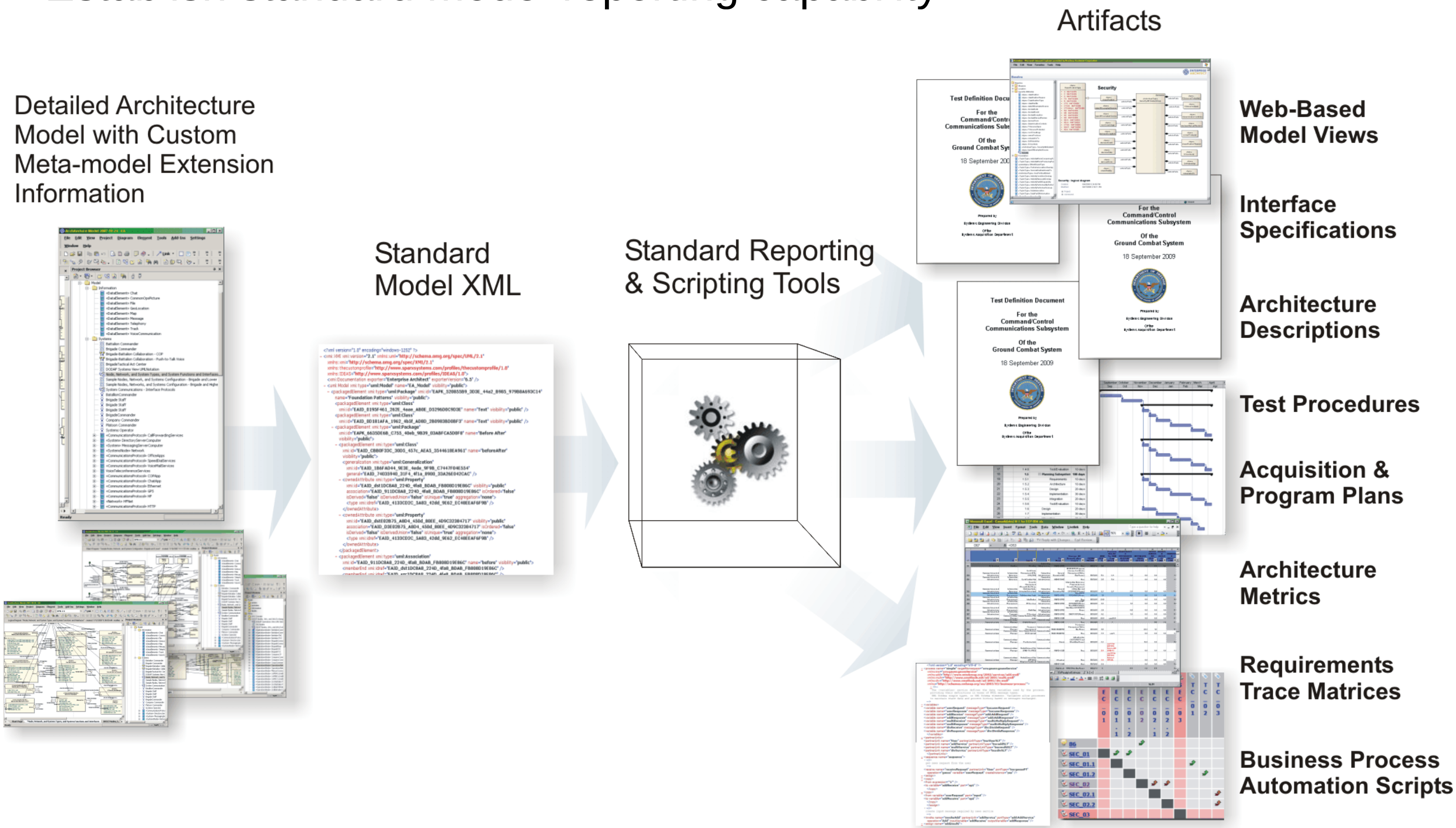
- Extend meta-model with user-definable extensions (tagging) …



Recommendations

Auto-generation of systems engineering artifacts (cont'd)

- Establish standard model reporting capability



Summary

In summary…

DoDAF v2 improves on satisfaction of SE needs, but systems engineers need greater definition and standardization of semantics and methods that are important to them.

Comments, questions, feedback are solicited. Contact…
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Human-Centered Design in Systems Engineering: Human View Methodology

Robert J. Smillie, PhD, CPE
Space and Naval Warfare Systems Command

NDIA Systems Engineering Conference
29 October 2009

Objective and Approach

- Examine dynamic aspects of Human View as an effective methodology for Human Systems Integration (HSI) practitioners coordinating and collaborating with systems engineers.
- Use data from system development effort to build Human Views.
- Use modeling and simulation to analyze dynamic operator elements of the system to augment Human View process.

In Practice

- Design, development, and production of large complex systems requires the HSI practitioner to ensure that HSI results, e.g., the task analysis, are communicated in a language that the systems engineer understands.
- An architecture framework provides that communication medium.

Architecture Frameworks

- Defines common approach for development, presentation, and integration of architecture descriptions.
- Architecture frameworks are used by systems engineers to provide a common set of products and product descriptions for representing systems.
- Current frameworks fail to capture the human-centered design aspects needed to ensure the effectiveness of human operated systems, such as users requirements, capabilities and limitations.

Department of Defense Architecture Framework (DODAF)

- DoDAF defines different views that breakdown a complex system into specific categories:
  - All View - Describes the Scope and Context (Vocabulary) of the Architecture
  - Operational View - Identifies What Needs to be Accomplished
  - Systems and Services View - Relates Systems, Services, and Characteristics to Operational Needs
  - Technical Views - Prescribes Standards and Conventions
- Each of the four views depicts certain architecture attributes -some attributes bridge two views and provide integrity, coherence, and consistency to architecture descriptions.
- However, none of these conventions focus explicitly on the human element - by adding a Human View to the architecture framework, an understanding of the human role in systems/enterprise architectures is included.

Emergence of the Human View

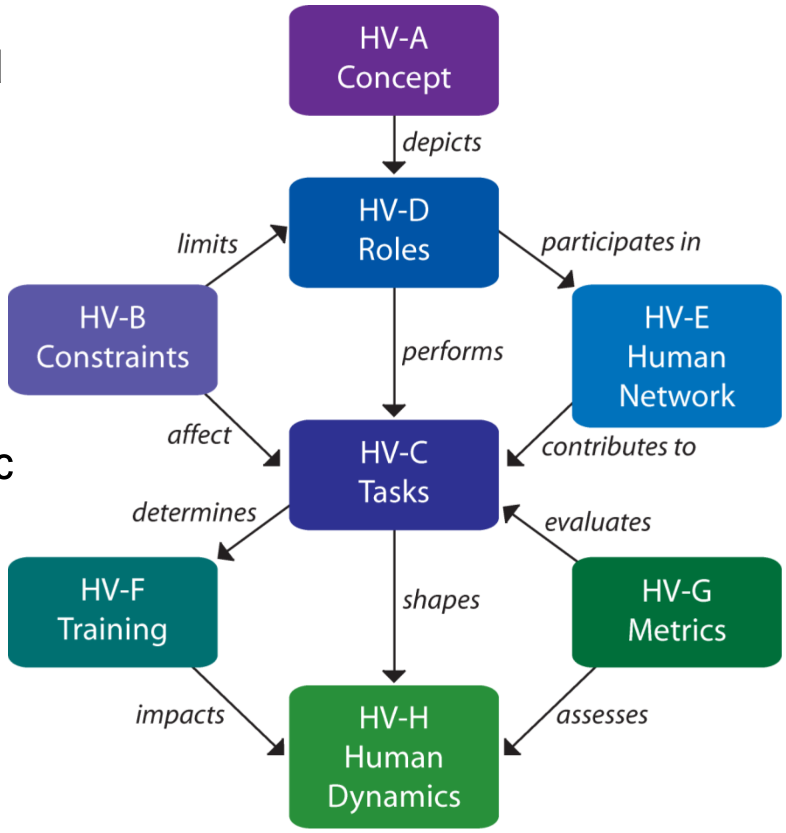
- Early efforts to represent humans in architecture products focused on human role and activities.
  - Hildebrand and Adams, 2002
  - Handley, 2006
- Additional analytical efforts in both Canada (DNDAF) and United Kingdom (MoDAF) have been concerned with how to include human activities in architecture framework.
  - Baker et al, 2006
  - Bruseberg, 2008
- Human View methodology provides HSI practitioner a mechanism to convey an understanding of human role in systems/enterprise architectures to systems engineers.

Human View

- Purpose is to organize information into a framework about how the human functions in the system in order to model the impacts of human performance from tasks, personnel, and system resources.
- Provides a set of products which captures information on *Capabilities, Constraints, Tasks, Roles, Networks, Training, and Metrics,* which are integrated with a dynamic model used to determine human risk.
- By using the Human View
  - It ensures that the human is fully considered in the architecture by structurally incorporating them into engineering planning.
  - It provides human-system parameters that can be used to minimize human risk with the overall system.

Human View Product Descriptions

- *HV-A* : Concept - A conceptual, high-level representation of the human component of the enterprise architecture framework.
- *HV-B* : Contraints - Sets of characteristics that are used to adjust the expected roles and tasks based on the capabilities and limitations of the human in the system.
- *HV-C*: Tasks - Descriptions of the human-specific activities in the system.
- *HV-D*: Roles - Descriptions of the roles that have been defined for the humans interacting with the system.
- *HV-E*: Human Network - The human to human communication patterns that occur as a result of ad hoc or deliberate team formation, especially teams distributed across space and time.
- *HV-F*: Training - A detailed accounting of how training requirements, strategy, and implementation will impact the human.
- *HV-G*: Metrics - A repository for human-related values, priorities and performance criteria, and maps human factors metrics to any other Human View elements.
- *HV-H*: Human Dynamics - Dynamic aspects of human system components defined in other views.



Example: HV-A

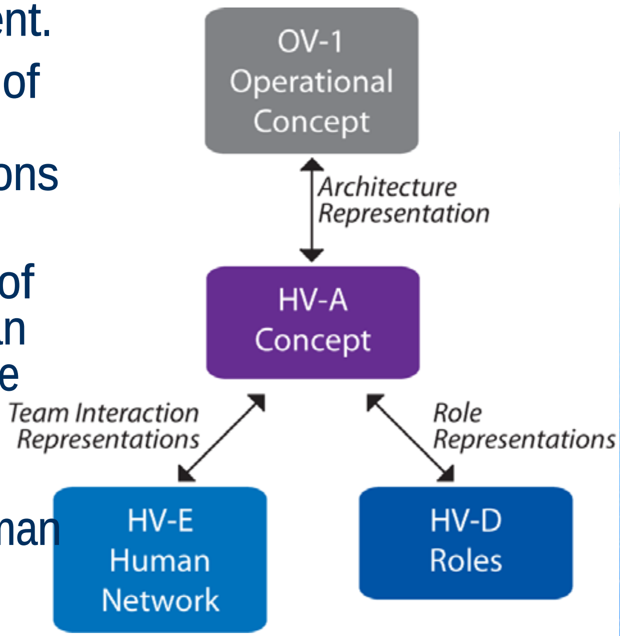
- HV-A is a conceptual, high-level representation of the human component of the enterprise architecture framework. Its purpose is to visualize and facilitate understanding of the human dimension in relation to operational demands and system components.

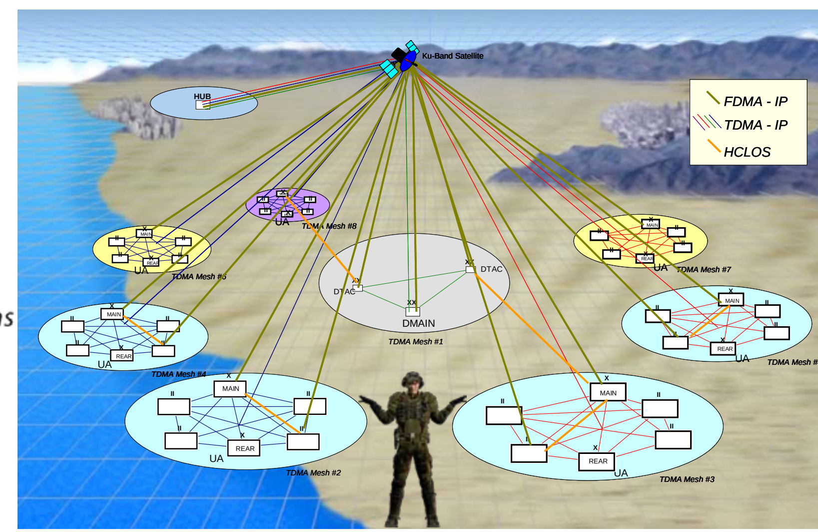
Pictorial depictions of the system and its human component.

High level indicators of where human system interactions may occur.

Textual descriptions of the overall human component of the system.

Use cases which describe the human process.





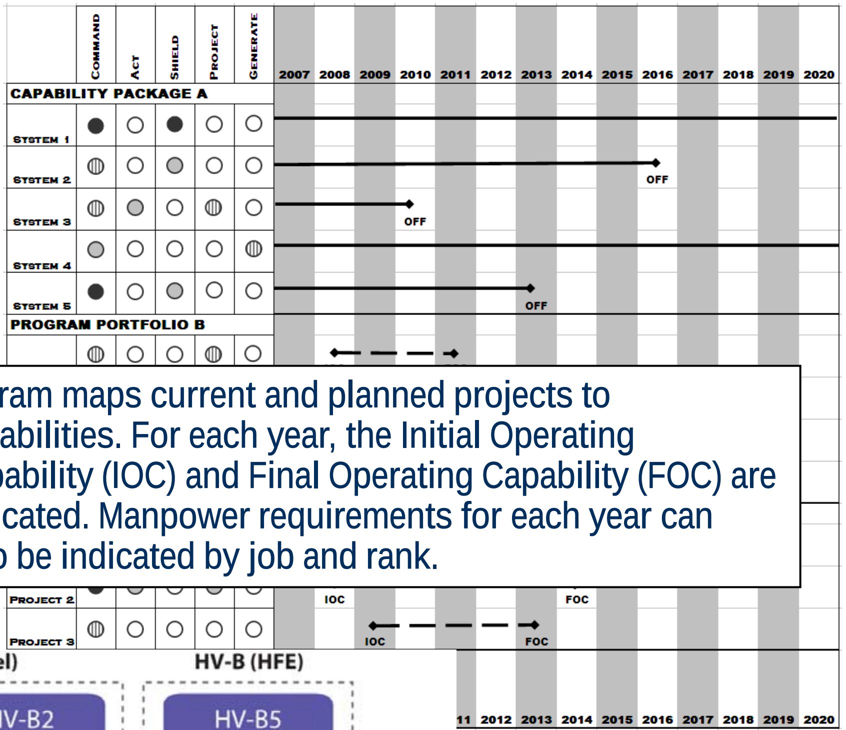
Example: HV-B

- Manpower Projections (HV-B1) illustrates predicted manpower requirements for supporting present and future projects that contribute to larger capabilities.

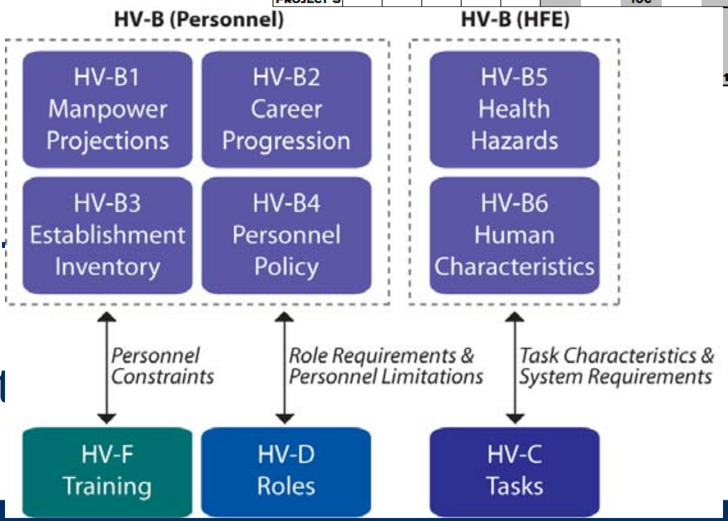
Manpower forecasting to allow initial adjustments in training, recruiting, professional development, assignment and personnel management.

Impacts (and timeframe) related to numbers of personnel, personnel mix, Military Occupational Structure Identification (MOSIDs), Rank/level distribution, and, postings/relocations of personnel.

Number of personnel with necessary Knowledge, Skills, and Abilities (KSAs) 'ready and able' to support fielding of future program.



This diagram maps current and planned projects to capabilities. For each year, the Initial Operating Capability (IOC) and Final Operating Capability (FOC) are indicated. Manpower requirements for each year can also be indicated by job and rank.



Example: HV-E

- The HV-E captures the human to human communication patterns that occur as a result of ad hoc or deliberate team formation, especially teams distributed across space and time.

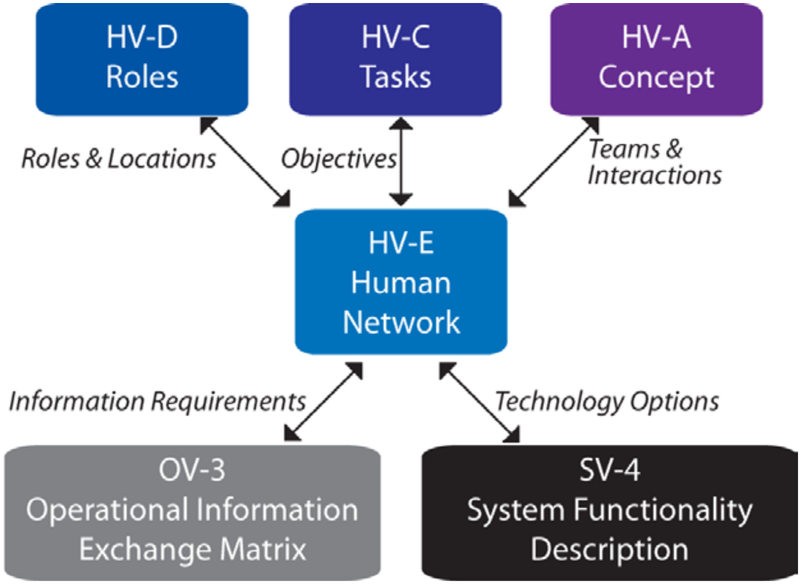
Role groupings or teams formed, including the physical proximity of the roles and virtual roles included for specific team tasks.

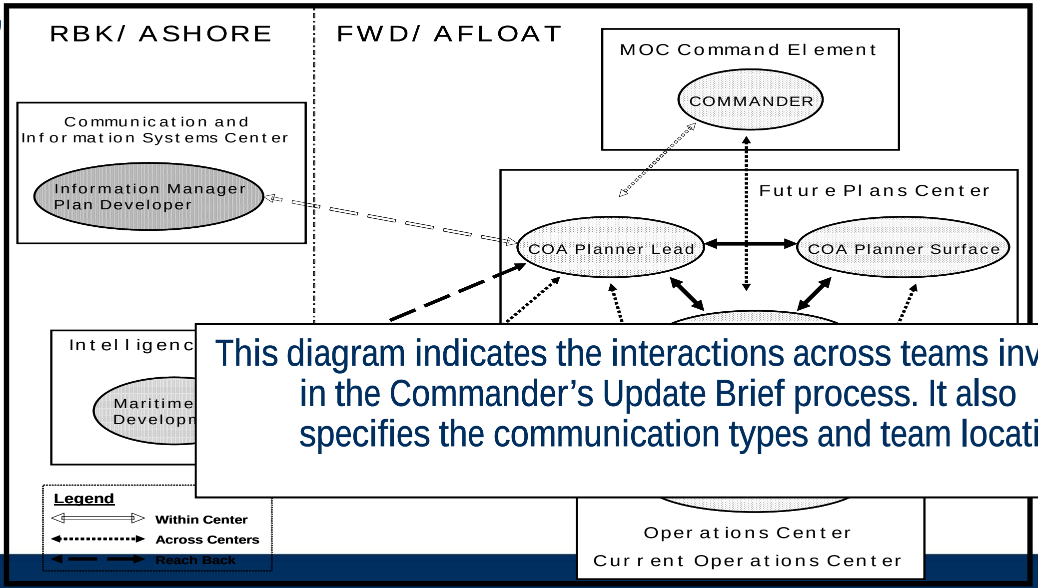
Type of interaction – i.e., collaborate, coordinate, supervise, etc.

Team cohesiveness indicators - i.e., trust, sharing, etc.

Team performance impacts - i.e., synchronization (battle rhythm), level of engagement (command directed).

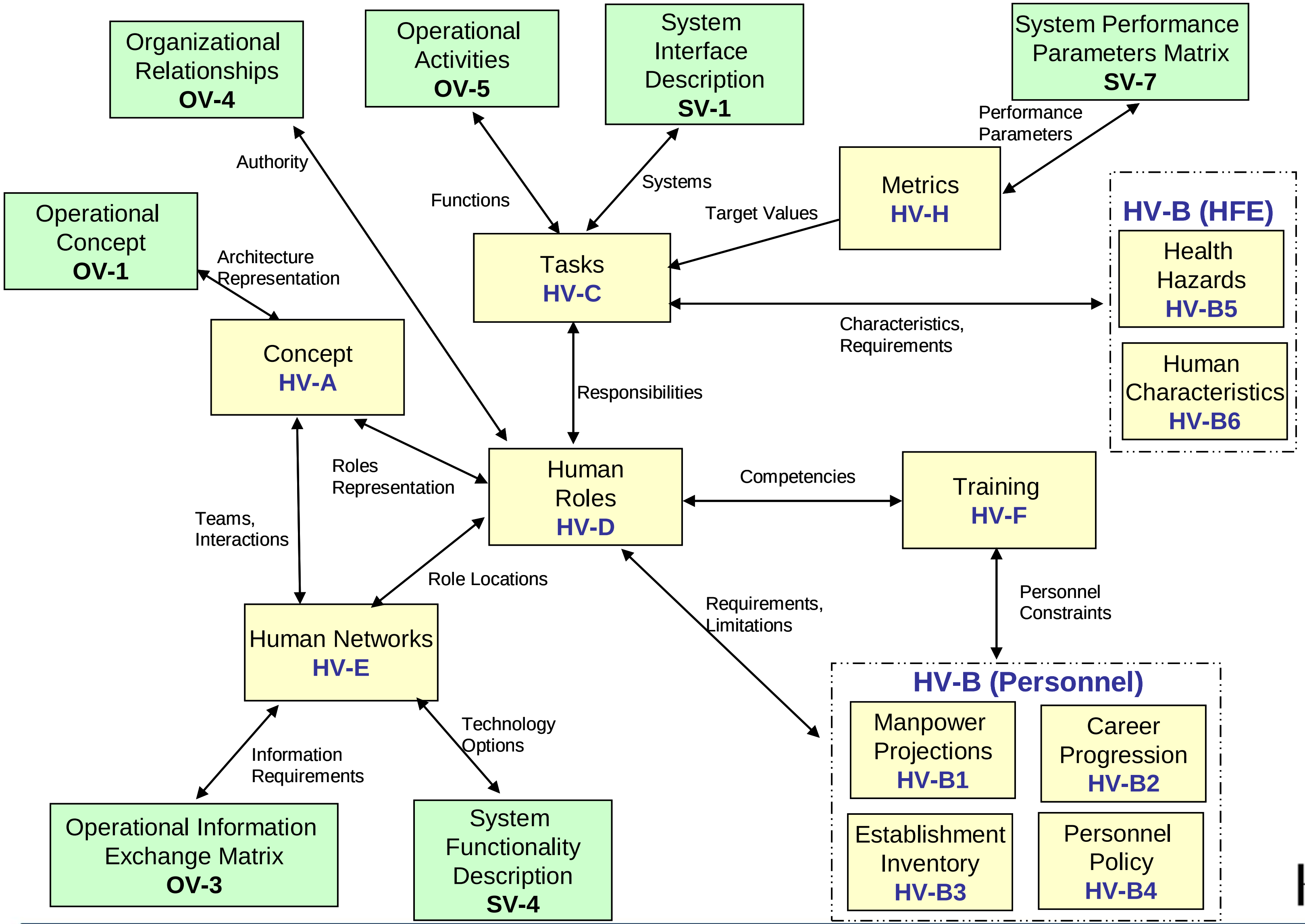
Team dependencies - i.e., frequency/degree of interaction between roles.





This diagram indicates the interactions across teams involved in the Commander's Update Brief process. It also specifies the communication types and team locations.

Human View Interaction with DoDAF



Human View Case Study

- Used Improved Performance Research Integration Tool (IMPRINT).
  - Stochastic task-network modelling tool to help assess interaction of people and system performance from concept and design through field-testing and system upgrades. (Mitchell et al, 2008)
  - Helps researchers and designers evaluate operator mental workload while testing alternate system-operator function allocations. (Wickens, 1991)
- Purpose of the dynamic Human View is to capture the interaction of the human system components.
  - An effective modeling and simulation tool can assess the static Human View data under dynamic situations and provide the system engineer designers with a robust set of HSI criteria.

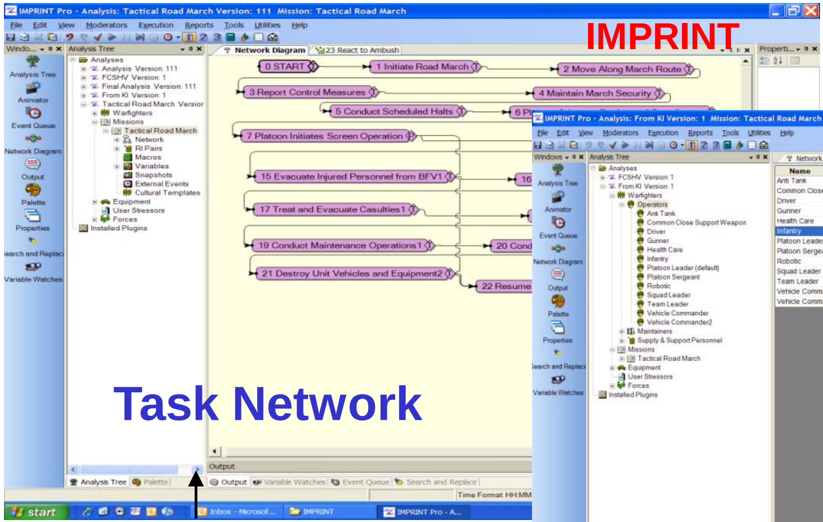
Dynamic Model Elements

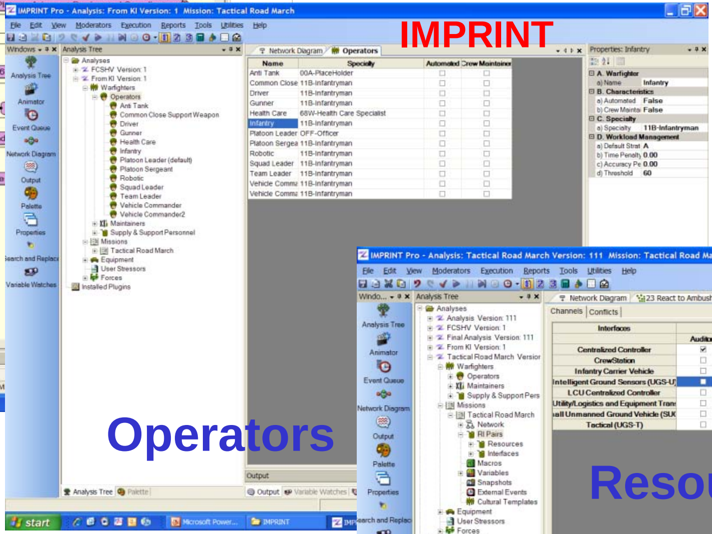
Human View Product	Data Required by Simulation Model
HV-A Concept	Hypothesis to be tested by the model.
HV-B Constraints	Selection of the Moderator settings of Personnel and Stressors.
HV-C Tasks	Generation of the Network Diagram composed of Tasks and Subtasks; Assignment of System Interfaces to Tasks.
HV-D Roles	Creation of Operator list; Assignment of Operators to Tasks.
HV-E Human Network	Identification of Team Functions and Operator Teams.
HV-F Training	Selection of the Moderator setting of Training.
HV-G Metrics	Identification of Mission Level Time & Accuracy criterion and selection of Task Level Time & Accuracy standards.

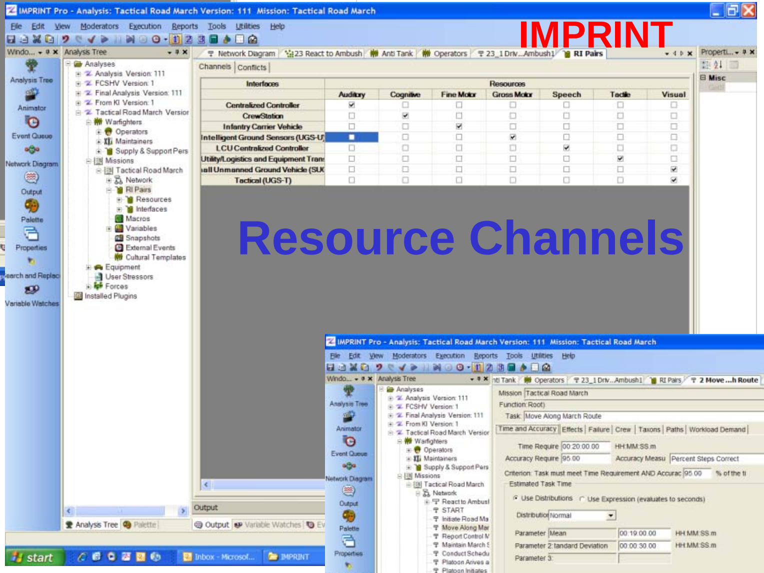
Method

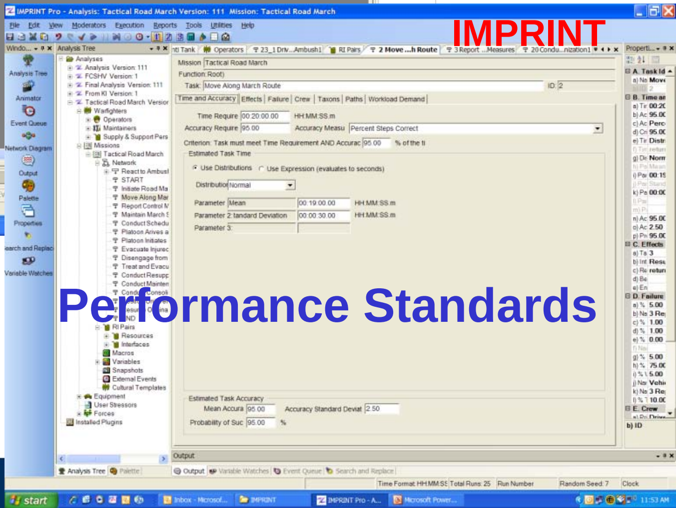
- Used U.S. Army's Future Combat System.
- Created experimental model in IMPRINT.
  - Operators were defined by the Human View roles.
  - Task descriptions were used to create a network diagram for a specified mission.
  - Task-role combination provided the operator assignments.
  - Performance standards/measures were used to define the expected task times, accuracy, and outcomes.
  - Constraints determine moderators that impact performance (e.g., heat, etc.).
  - IMPRINT outputs provide data that describe overall success/failure of the mission, task performance completion and potential errors, and operator workload.
- Results used to support systems engineering process to ensure human/operator requirements are met.

Dynamic Model Inputs









Interfaces (HV-E)

HV-C2 System Interfaces	
Role	**System**
Platoon Leader	1 LCU Centralized Controller; 2 Centralized Controller, Tactical (UGS-T)
Platoon Sergeant	Multifunction Utility/Logistics and Equipment Transport (MULE-T)
Vehicle Commander	
Squad Leader	3 Centralized Controllers; Small Unmanned Ground Vehicle (SUGV)
Robotic	Armed Rconnaissance Vehicle (ARV-A); Class 1 unmanned Aircraft System (UAS)
Team Leader	6 sets Intelligent Ground Sensors (UGS-U)
Health Care	
Driver	Infantry Carrier Vehicle
Infantry	MK 44 30MM; MK240 7.62MM;

Tasks (HV-C)

	HV-C TASKS		
	Platoon Level	**Squad Level**	**Soldier Level**
	Conduct Tactical Road March		
		Initiate Road March	
		Move Along March Route	
		Report Control Measures	
		Maintain March Security	
		Conduct Scheduled Halts	
		Platoon Arrives at Designated Coordinates	
		Platoon Initiates Screen Operation	
Enemy initiates Ambush			
	React to Ambush Near		
			Driver Reacts to Ambush
			Vehicle Gunner Reacts to Ambush
			Vehicle Commander Reacts to Ambush
			Infantry Squad Reacts to Ambush
			Platoon Leader Reacts to Ambush
		Evacuate Injured Personnel from BFV	
		Disengage From An Enemy Force	
		Treat and Evacuate Casulties	
		Conduct Resupply Operations	
		Conduct Maintenance Operations	
		Conduct Consolidation and Reorganization	
		Destroy Unit Vehicles and Equipment	
		Resume Original Mission	

Roles (HV-D)

HV-D Roles		
Abbreviation	**Role Name**	**MOS**
PL 02	*Platoon Leader*	*11A*
PSG/VC E7	*Platoon Sergeant*	*11B40*
VC E6	*Vehicle Commander*	*11B30*
SL E6	*Squad Leader*	*11B30*
VC E5	*Vehicle Commander*	*11B20*
RBTIC E5	*Robotic*	*11B20*
TL E5	*Team Leader*	*11B20*
HC E4	*Health Care*	*68W10*
DVR E4	*Driver*	*11B10*
INF E4	*Infantry*	11B10
CCSW E4	Common Close Support Weapon	11B10
A/GNR E4	Gunner	11B10
A-Tank E4	Anti Tank	11B10

Metrics (HV-G)

HV-G Standards
Task Performance:
•95% Reliability
•95% Accuracy

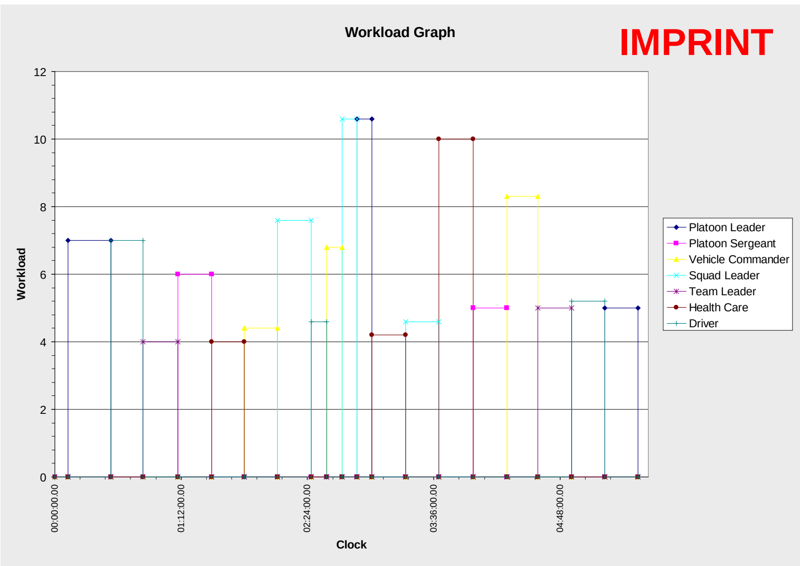
Approach

- Baseline simulation was executed to provide expected levels of mission performance parameters of time and accuracy.
  - IMPRINT provides for the overall development of a network task model that accounts for the tasks and the types and numbers of operators performing those tasks.
  - It also provides the opportunity to examine the effects of unexpected outcomes.

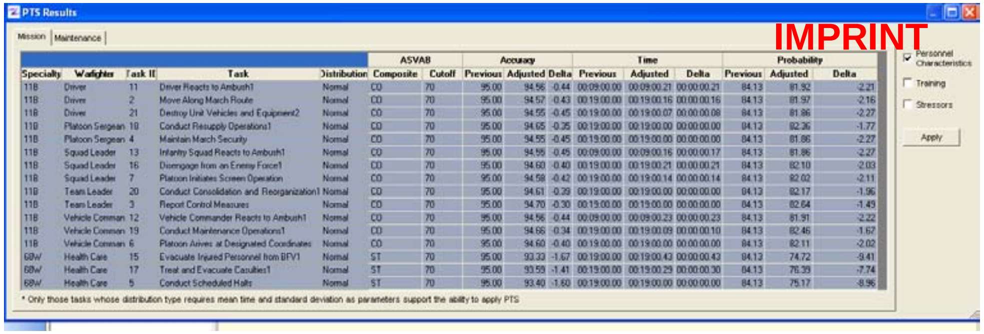
- Simulation was run multiple times, the outcome measures were analyzed in terms of performance and workload.

Dynamic Model Outputs

Operator Workload



Impact of Constraints



					ASVAB		Accuracy			Time			Probability		
Specialty	Warfighter	Task ID	Task	Distribution	Composite	Cutoff	Previous	Adjusted	Delta	Previous	Adjusted	Delta	Previous	Adjusted	Delta
11B	Driver	11	Driver Reacts to Ambush1	Normal	CO	70	95.00	94.56	-0.44	00:09:00.00	00:09:00.21	00:00:00.21	84.13	81.92	-2.21
11B	Driver	2	Move Along March Route	Normal	CO	70	95.00	94.57	-0.43	00:19:00.00	00:19:00.16	00:00:00.16	84.13	81.97	-2.16
11B	Driver	21	Destroy Unit Vehicles and Equipment2	Normal	CO	70	95.00	94.55	-0.45	00:19:00.00	00:19:00.07	00:00:00.08	84.13	81.86	-2.27
11B	Platoon Sergean	10	Conduct Resupply Operations1	Normal	CO	70	95.00	94.65	-0.35	00:19:00.00	00:19:00.00	00:00:00.00	84.13	82.36	-1.77
11B	Platoon Sergean	4	Maintain March Security	Normal	CO	70	95.00	94.55	-0.45	00:19:00.00	00:19:00.00	00:00:00.00	84.13	81.86	-2.27
11B	Squad Leader	13	Infantry Squad Reacts to Ambush1	Normal	CO	70	95.00	94.55	-0.45	00:09:00.00	00:09:00.16	00:00:00.17	84.13	81.86	-2.27
11B	Squad Leader	16	Disengage from an Enemy Force1	Normal	CO	70	95.00	94.60	-0.40	00:19:00.00	00:19:00.21	00:00:00.21	84.13	82.10	-2.03
11B	Squad Leader	7	Platoon Initiates Screen Operation	Normal	CO	70	95.00	94.58	-0.42	00:19:00.00	00:19:00.14	00:00:00.14	84.13	82.02	-2.11
11B	Team Leader	20	Conduct Consolidation and Reorganization1	Normal	CO	70	95.00	94.61	-0.39	00:19:00.00	00:19:00.00	00:00:00.00	84.13	82.17	-1.96
11B	Team Leader	3	Report Control Measures	Normal	CO	70	95.00	94.70	-0.30	00:19:00.00	00:19:00.00	00:00:00.00	84.13	82.64	-1.49
11B	Vehicle Comman	12	Vehicle Commander Reacts to Ambush1	Normal	CO	70	95.00	94.56	-0.44	00:09:00.00	00:09:00.23	00:00:00.23	84.13	81.91	-2.22
11B	Vehicle Comman	19	Conduct Maintenance Operations1	Normal	CO	70	95.00	94.66	-0.34	00:19:00.00	00:19:00.09	00:00:00.10	84.13	82.46	-1.67
11B	Vehicle Comman	6	Platoon Arives at Designated Coordinates	Normal	CO	70	95.00	94.60	-0.40	00:19:00.00	00:19:00.00	00:00:00.00	84.13	82.11	-2.02
68W	Health Care	15	Evacuate Injured Personnel from BFV1	Normal	ST	70	95.00	93.33	-1.67	00:19:00.00	00:19:00.43	00:00:00.43	84.13	74.72	-9.41
68W	Health Care	17	Treat and Evacuate Casulties1	Normal	ST	70	95.00	93.59	-1.41	00:19:00.00	00:19:00.29	00:00:00.30	84.13	76.39	-7.74
68W	Health Care	5	Conduct Scheduled Halts	Normal	ST	70	95.00	93.40	-1.60	00:19:00.00	00:19:00.00	00:00:00.00	84.13	75.17	-8.96

* Only those tasks whose distribution type requires mean time and standard deviation as parameters support the ability to apply PTS

Mission Success Rates

IMPRINT

Run	Mission Performance Time	RNS	Accuracy Result
1	05:38:13.78	2	No failure
2	05:38:11.31	3	No failure
3	05:36:48.93	4	No failure
4	05:39:56.18	5	No failure
5	05:40:36.60	6	No failure
6	05:41:00.88	7	No failure
7	05:39:12.05	8	No failure
8	05:36:08.66	9	No failure
9	05:40:42.82	10	No failure
10	05:39:38.28	11	No failure
11	05:39:10.11	12	No failure
12	05:34:43.11	13	No failure
13	05:38:48.06	14	No failure
14	05:39:44.32	15	No failure
15	05:35:47.95	16	No failure
16	05:55:01.82	17	No failure
17	05:37:18.57	18	No failure
18	05:38:39.54	19	No failure
19	05:40:10.08	20	No failure
20	05:38:52.16	21	No failure
21	05:35:53.98	22	No failure
22	06:00:09.75	23	No failure
23	05:36:05.52	24	No failure
24	05:38:45.16	25	No failure
25	05:37:21.77	26	No failure

Individual Task Performance

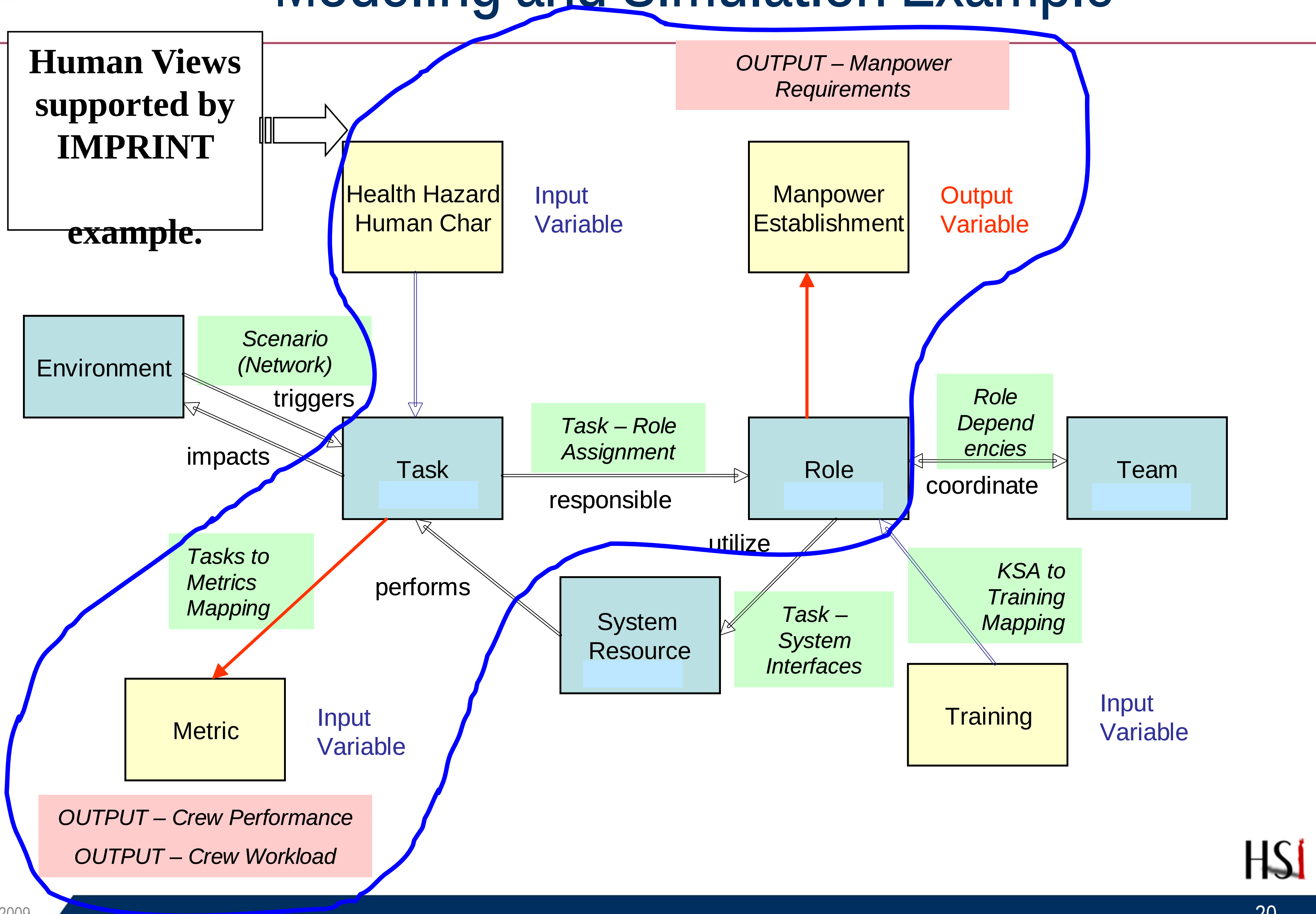
IMPRINT

	Time						Accuracy				Overall	
Task	Standard	Minimum	Maximum	Mean	Std. Dev.	% Met	Accuracy Standard	Accuracy Measure	% Met	Mission Aborts	% Met Both Time AND Accuracy	Result
START	00:08:00.00	00:05:57.80	00:07:29.40	00:06:52.21	00:00:25.76	100.00	90.00	Percent Steps Correct	100.00	0	100.00	This DOES meet the performance criterion of 90%
Initiate Road March	00:25:00.00	00:23:01.37	00:25:13.73	00:24:08.51	00:00:31.39	96.00	90.00	Percent Steps Correct	92.00	0	88.00	This does NOT meet the performance criterion of 90%
Move Along March Route	00:20:00.00	00:17:30.67	00:20:07.57	00:19:02.03	00:00:33.38	96.00	90.00	Percent Steps Correct	100.00	0	96.00	This DOES meet the performance criterion of 90%
Report Control Measures	00:20:00.00	00:18:11.83	00:20:22.81	00:18:55.64	00:00:34.64	96.00	90.00	Percent Steps Correct	92.00	0	88.00	This does NOT meet the performance criterion of 90%
Maintain March Security	00:20:00.00	00:17:40.71	00:19:59.11	00:18:47.98	00:00:34.83	100.00	90.00	Percent Steps Correct	100.00	0	100.00	This DOES meet the performance criterion of 90%
Conduct Scheduled Halts	00:20:00.00	00:18:00.54	00:19:32.56	00:18:56.32	00:00:21.07	100.00	90.00	Percent Steps Correct	100.00	0	100.00	This DOES meet the performance criterion of 90%
Platoon Arives at Designated Coordinates	00:20:00.00	00:18:16.84	00:19:34.86	00:18:58.48	00:00:20.44	100.00	90.00	Percent Steps Correct	96.00	0	96.00	This DOES meet the performance criterion of 90%
Platoon Initiates Screen Operation	00:20:00.00	00:17:56.41	00:20:14.44	00:19:04.15	00:00:31.37	92.00	90.00	Percent Steps Correct	96.00	0	88.00	This does NOT meet the performance criterion of 90%
Driver Reacts to Ambush1	00:10:00.00	00:08:19.06	00:10:09.37	00:09:11.21	00:00:30.59	96.00	90.00	Percent Steps Correct	92.00	0	88.00	This does NOT meet the performance criterion of 90%
Vehicle Commander Reacts to Ambush1	00:10:00.00	00:07:56.72	00:09:52.43	00:09:00.04	00:00:24.85	100.00	90.00	Percent Steps Correct	96.00	0	96.00	This DOES meet the performance criterion of 90%
Infantry Squad Reacts to Ambush1	00:10:00.00	00:08:17.82	00:09:47.78	00:08:50.08	00:00:25.59	100.00	90.00	Percent Steps Correct	92.00	0	92.00	This DOES meet the performance criterion of 90%
Platoon Leader Reacts to Ambush1	00:10:00.00	00:08:02.94	00:09:32.83	00:08:52.93	00:00:24.06	100.00	90.00	Percent Steps Correct	100.00	0	100.00	This DOES meet the performance criterion of 90%
Evacuate Injured Personnel from BFV1	00:20:00.00	00:17:34.35	00:19:54.06	00:18:50.51	00:00:31.65	100.00	90.00	Percent Steps Correct	92.00	0	92.00	This DOES meet the performance criterion of 90%
Disengage from an Enemy Force1	00:20:00.00	00:17:57.22	00:20:03.71	00:19:00.60	00:00:36.99	92.00	90.00	Percent Steps Correct	76.00	0	68.00	This does NOT meet the performance criterion of 90%
Treat and Evacuate Casulties1	00:20:00.00	00:17:36.50	00:19:50.97	00:19:05.12	00:00:33.61	100.00	90.00	Percent Steps Correct	92.00	0	92.00	This DOES meet the performance criterion of 90%
Conduct Resupply Operations1	00:20:00.00	00:18:23.12	00:19:57.86	00:19:03.19	00:00:28.29	100.00	90.00	Percent Steps Correct	92.00	0	92.00	This DOES meet the performance criterion of 90%
Conduct Maintenance Operations1	00:20:00.00	00:17:37.41	00:19:45.42	00:18:54.63	00:00:27.62	100.00	90.00	Percent Steps Correct	96.00	0	96.00	This DOES meet the performance criterion of 90%
Conduct Consolidation and Reorganization1	00:20:00.00	00:17:47.45	00:20:06.05	00:19:01.20	00:00:32.18	92.59	90.00	Percent Steps Correct	92.59	0	85.19	This does NOT meet the performance criterion of 90%
Destroy Unit Vehicles and Equipment2	00:20:00.00	00:17:55.55	00:19:38.60	00:18:52.68	00:00:24.30	100.00	90.00	Percent Steps Correct	96.00	0	96.00	This DOES meet the performance criterion of 90%
Resume Original Mission2	00:20:00.00	00:18:10.37	00:20:05.01	00:18:59.88	00:00:30.03	96.00	90.00	Percent Steps Correct	100.00	0	96.00	This DOES meet the performance criterion of 90%
END	00:07:00.00	00:04:51.16	00:06:36.74	00:05:54.19	00:00:26.88	100.00	90.00	Percent Steps Correct	96.00	0	96.00	This DOES meet the performance criterion of 90%

Simulation Results

- Simulation output identified tasks that did not meet the Future Combat System accuracy standard.
- IMPRINT outputs of operator workload and resource conflicts were further investigated to determine if an overloaded condition or a resource shortage contributed to the accuracy detriment of the tasks.
- Analysis verified that the Human View static products can be used to structure the input data to a simulation tool, such as IMPRINT, to provide the simulation environment for the dynamic Human View.
- The dynamic Human View is critical in the architecture framework approach because it captures the dynamic aspects of the human system components defined in other views.

Human View Products Supported by Modeling and Simulation Example



Comments – 1

- Several efforts in various countries are underway to define and structure Human View as viable methodology for HSI practitioners to coordinate and collaborate with the system engineers.

  [Example: UK MODAF Human View]

- While the ergonomists always had a set of tools and processes to support system development (e.g., task analysis, function allocation, etc.), the Human View products facilitate a more structured language for communicating with the other engineering disciplines during system development.

Comments – 2

- The Human View products are derived using an ergonomic approach, namely, a top down method analyzing human gaps in existing architecture frameworks, or based on specific needs that evolved during the course of the architecture development to capture specific human view data.

- HSI practitioners can use Human View methodology to provide a fully integrated set of products that ensure an effective and efficient design, development, and production process.

Conclusions

- Human View products facilitate a more structured language for communicating with other disciplines during system development.
- HSI practitioners can use Human View methodology to provide a fully integrated set of products that ensure an effective and efficient design, development, and production process.
- Analysis results demonstrated that Human View data for a complex system, such as the Future Combat System, can be used to assess design impacts when combined with a simulation tool, such as, IMPRINT.
- Dynamic Human View is critical in the architecture framework because it captures the dynamic aspects of the human system components defined in other views.

BAE SYSTEMS

BAE Systems

U.S. Combat Systems

Tailoring Systems Engineering for Technical Support of Legacy Products

M88 HERCULES Recovery System

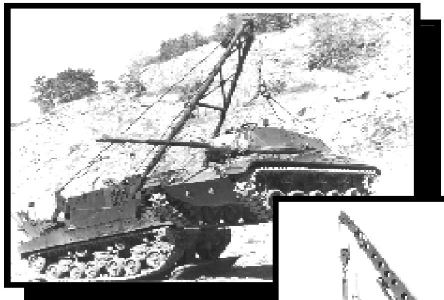
Presented by: Joe Skandera, Derrick Min and Virginia Doyle

BAE SYSTEMS

Agenda

- **Introduction**
- Schedule Development
- Requirements Management
- Risk Management
- Summary

50+ Years Designing/Manufacturing Over 6400 Recovery Systems




- **1951: Designed the M74, First Recovery Vehicle with Hydraulic Powered Recovery Systems**
- **1953: Contract Award to convert 1,100 M4A3's to M74 RV's**
- **1954: Designed and Prototyped 3 T-88 Recovery vehicles**
- **1960: Contract Award for 1,075 M88A0 Recovery vehicles**
- **1963: 1,000 M88 Produced**
- **1965: Production of 1,844 M578 Light Recovery vehicles begins**
- **1972: 875 Vehicle M88 Conversion to Diesel Contract Awarded**
- **1975: M88A1**
- **1982: M88AX Automotive Demonstrator Design**
- **1987: M88A1E1 Prototype Contract**
- **1993 5 M88A1E1's Complete Testing**
- **1994: LRIP Award for M88IRV (M88A2 production begins)**
- **1997: M88A2**
- **2009: 491 M88A2 vehicles delivered to customers globally**
- **Today: Over 2000 M88 vehicles are in service**

M88 Family of Vehicles History

M88 FOV

M88A0-1960

55 TONS

Recovery of M48-M60 Tanks

- M88 Steel Fabricated Hull
- AVIS-1790-6A, 12 Cylinder Petrol Engine
- It was the First Armored Recovery Vehicle to be Designed, Produced, and Fielded as a New System
- Mechanical Transmission

M88A1-1975

56 TONS

Recovery of M48-M60 Tanks

- M88 Steel Fabricated Hull
- AVDS-1790-2DR, 12 Cylinder Diesel Engine (750 HP)
- Increased Operating Range from 360 to 450 km
- Modified Transmission
- Diesel Fired Personnel Heater
- Auxiliary Power Unit

M88A2 HERCULES-1997

70 TONS

Recovery of M1A1/M1A2 Tanks

- M88 Steel Fabricated Hull
- AVDS-1790-8CR 12 Cylinder Diesel Engine (1050 HP)
- Recovery for 70 Ton MBT
  - 20-25% Improved Towing
  - 55% Improved Main Winch
  - 40% Improved Hoist winch
- Added Auxiliary Winch
- Improved Ballistic Protection
- Laser Protected Vision Blocks/Scope
- Enhanced Hydraulic Diagnostics

Baseline Configuration
Enhancements

Agenda

- Introduction
- **Schedule Development**
- Requirements Management
- Risk Management
- Summary

Schedule Development

- What is the most popular way to plan schedules?
  - SOW to Solution Confusion

  - Reverse thinking and define measurement needs first
    - Is EVMS, CPI and SPI required and supported by funding or will something simpler work?
    - Defining these measures can help indicate depth of WBS detail

  - Then dissect the SOW to develop a WBS based on deliverables
    - Socialize with your IPT- your life depends on it - train as needed - gain agreement & approval
    - WBS sets the stage for responsibilities

  - Define time phased sequence of events including internal & external reviews, decision gates and milestones that end in deliverables

    (referred to as a Summary Schedule or Horse Blanket Schedule)

Schedule Development – continued

- $1B Question
  - How deep do we dive to reach deliverables?
    - What does the customer require and is there funding to support it?
    - What is the size and complexity of the project?
    - Is there any new technology development?
    - Who and what resources are needed for the project?
    - How accurate are the material estimates?
    - Do we need activities narrowed down to the point of selecting a bolt?
    - How urgent is the need? Do they need it tomorrow?

Continue Schedule Development

- The answers are based on legal requirements, your organizational requirements, customer requirements and the risk against deliverables
- Create a draft detailed schedule
- Socialize with the Project Team, Management and Customer for agreement
- Measure, monitor and continuously update the schedule methodology from lessons learned throughout execution

Remember - all the answers depend on the requirements and risks.

Agenda

- Introduction
- Schedule Development
- **Requirements Management**
- Risk Management
- Summary

Requirements Management

- Requirements for legacy systems may not be documented in typical Systems Engineering documentation and tools
- *What should be the approach to defining/refining requirements for technical support projects on legacy systems?*
- Requirements efforts must be tailored to fit the size and cost of the project
  - Establishing a requirements baseline
  - Clarifying ambiguously derived requirements

Successfully tailored requirements process helps to maintain budget, scope, and performance

Requirements Management – continued

- Example: Developing an automated hydraulic diagnostics on the M88A1
  - Research documentation for existing requirements
    - Statement of Work (SOW)
    - Purchase Description
    - Tech Manuals
    - Previous milestone review materials
    - Subject Matter Experts
    - Any potential source of data
  - Identify legacy system (vehicle) requirements that are relevant to hydraulic diagnostics
    - Operational requirements
    - Interface requirements
  - Baseline requirements determined at System Requirements Review (SRR)
    - Opportunity for customer to review requirements and traceability
  - Review updates to requirements at following milestone reviews

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Requirements Management – continued

- Tailoring Challenges
  - Appropriate level of requirements for the scope of the project
    - Over-committing can lead to cost/schedule overruns
    - Useful to consider verification/validation matrix, especially when addressing system-level requirements
  - Modeling and simulation may be limited in determining capability to meet requirements
    - System-level models may not exist, and may be too costly to develop within scope of the project
  - Cost-benefit and trade studies are beneficial in resolving conflicting requirements, especially when legacy technology is involved
  - Robust **Risk and Opportunity Management** is critical in maintaining cost and schedule
    - Provides a structured method to identify, assess, and communicate potential issues due to limited scope
    - Provides a structured method to identify performance and cost benefits which may be realized on current projects or follow-on projects
- Overall, requirements process is similar to “standard” requirements development
  - Process must be *appropriately* tailored to fit the project

Agenda

- Introduction
- Schedule Development
- Requirements Management
- **Risk Management**
- Summary

Risk Management

We all do risk management and mitigation, even if not formally documented.

- What are some examples?

How to manage risks at a level appropriate to the project?

Tailoring

Risk management is applicable on EVERY project.

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Risk Management - continued

Project (Work Directives) Examples

- Find a replacement for a major sub-assembly in the vehicle.
  - Customer active member of weekly team meetings
  - Approx $25M in funding
  - Risk approach -> Formal risk register at project level, team involved customer, costing of risks tracked separately, met at a minimum monthly to update status of actions, prioritized based on probability and impact.

- Work on improvements needed to bring older model up to date.
  - 13 tasks (develop, integrate, drawings, maintenance manuals, etc) under main title assigned to different project leads.
  - Approx $5M in funding
  - Risk approach -> Informal risk management at project/task level, risks captured formally in Engineering Program risk register, customer not involved in risk review board, monthly program risk meetings to update status of actions.

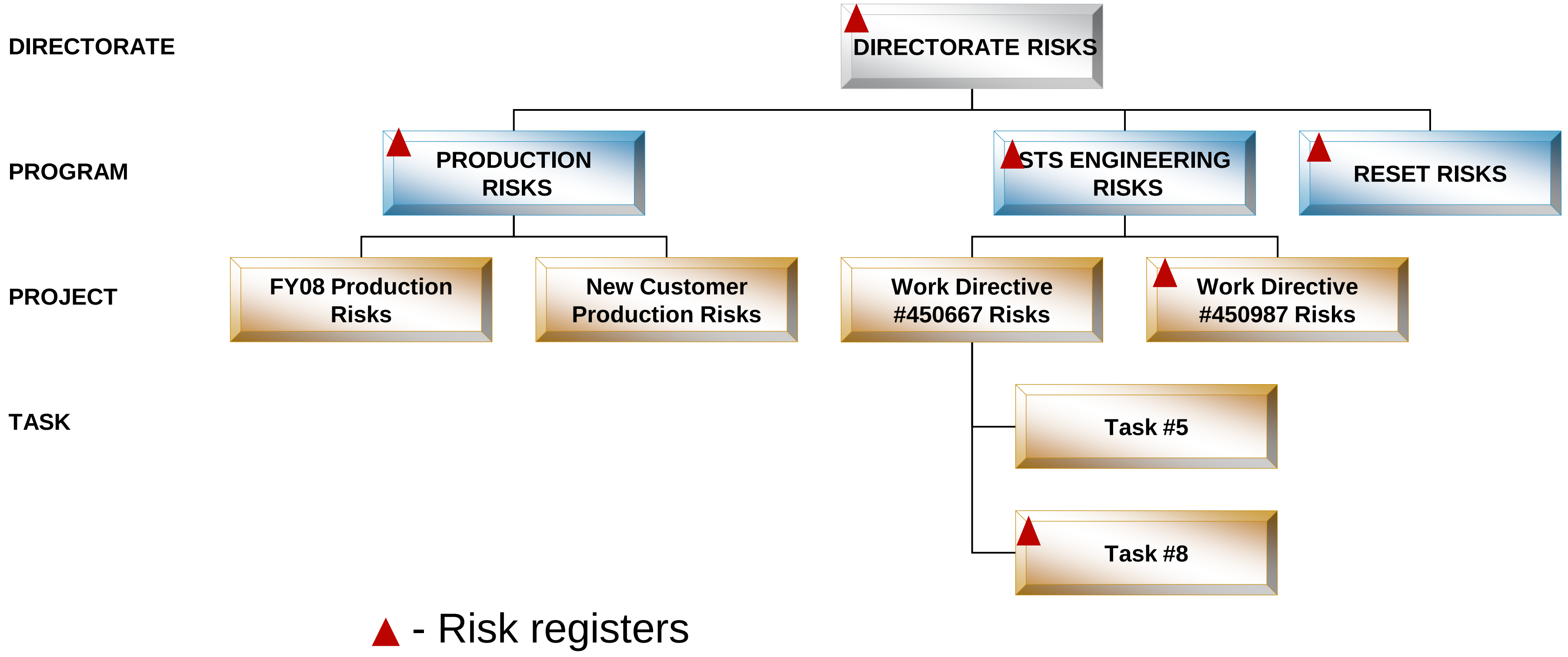
Risk Management - continued

- Establish basic requirements for all projects:
  - Statement (If…due to..., then…)
  - Handling Approach – If mitigation, include due dates and assignee.
  - Prioritization method
  - Periodic reviews
  - Contingency plans

- Tailor other areas of risk management:
  - Reporting frequency and structure
  - Level of detail
  - Costing approach
  - Project risks versus Program risks

Risk Management - continued

- Best approach when dealing with multiple levels of tailoring
  - Multiple levels of management



Agenda

- Introduction
- Schedule Development
- Requirements Management
- Risk Management
- **Summary**

Summary

Of the three areas covered, you can see importance of understanding the customer needs, cost, and type of each project.

- Where else could we apply this approach?
  - Verification and Validation
  - Quantitative Project Management

Just as you need a good CAST when you go fishing in order to place your bait in the stream to catch the elusive trout….

You need good tailoring of the Systems Engineering processes to effectively apply the techniques to result in a successful project!

So when you start a project, remember it's all about the CAST.

Summary - continued

C - Identify what the **customer** wants!
(timeframe of need, level of participation, etc)

A - **Assess** each project individually
(same approach does not apply to all)

S - Consider the **size** or funding level
(dollar amount, number of people, number of tasks, etc)

T - Consider the **type** of project
(development, integration, field support, reset, etc)

A good CAST produces accurate tailoring for project success.

Questions?

Producibility M&S Needs for Early Systems Engineering Evaluations of Alternative Design Concepts

Dr. Al Sanders

October 29, 2009

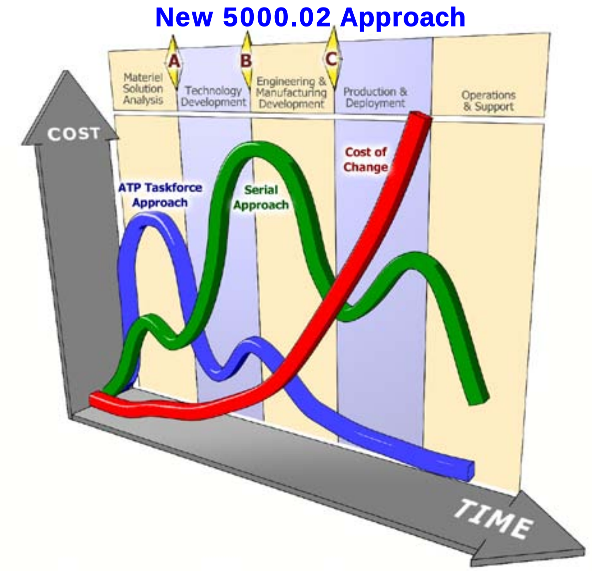
JCSEM M&S Sub-Committee

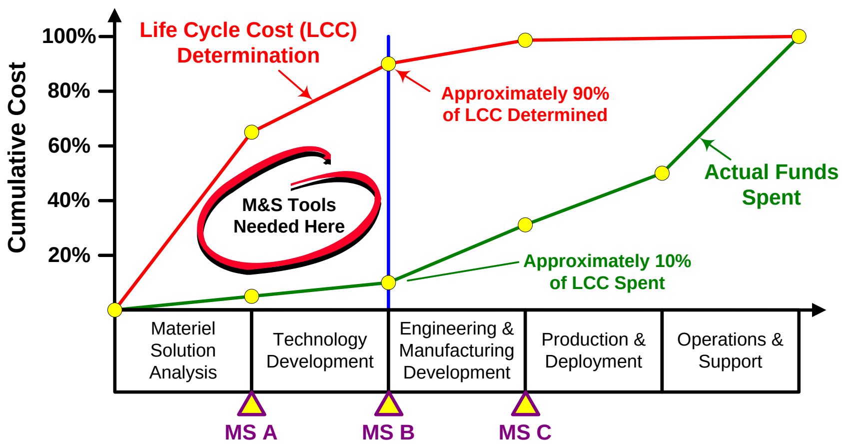
- Joint Committee for Systems Engineering & Manufacturing
  - Sponsored by NDIA Systems Engineering & Manufacturing Divisions
  - Chaired by Dr. Tom Christian (SE) and Mike Packer (Manufacturing)

- JCSEM M&S Sub-Committee Chartered in November 2008
  - Dr. Al Sanders – Chairman (Honeywell)
  - John Allen (Honeywell)
  - Kevin Fischer (Rockwell Collins)
  - Greg Pollari (Rockwell Collins)
  - Charlie Stirk (Cost Vision)
  - Dr. Gary Belie (LMCO)
  - Simon Frechette (NIST)
  - Tim Comerford (Missouri University)
  - Scott Frost (Anser)
  - Brench Boden (AFRL)

Early Productibility Focus Motivation

- **Early decisions responsible for many production ramp issues**
  - Actual costs exceed estimates
  - Quality levels below expectations
  - Low yield and delivery problems
  - Service and sustainability issues
  - Integration & assembly problems
  - Overall supply chain inefficiencies
- **DoDI 5000.02 implemented to drive earlier knowledge-based decisions**
  - Increased focus on SE discipline
  - Increased focus on manufacturing
  - Analysis-based approaches needed
  - Producibility most neglected "ility"
  - Producibility drives hidden costs





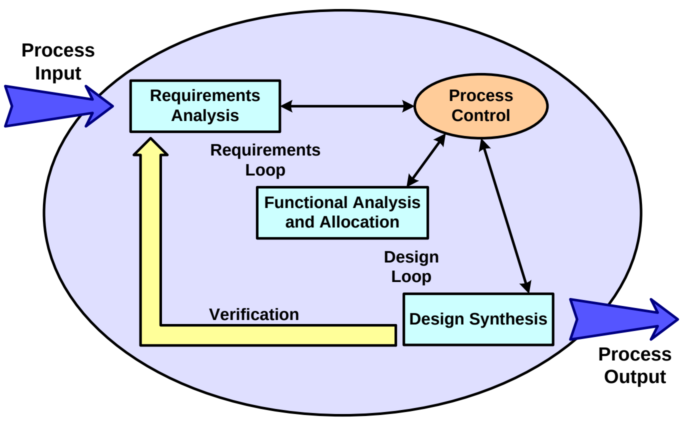
New Approaches Required to Address Producibility Risks

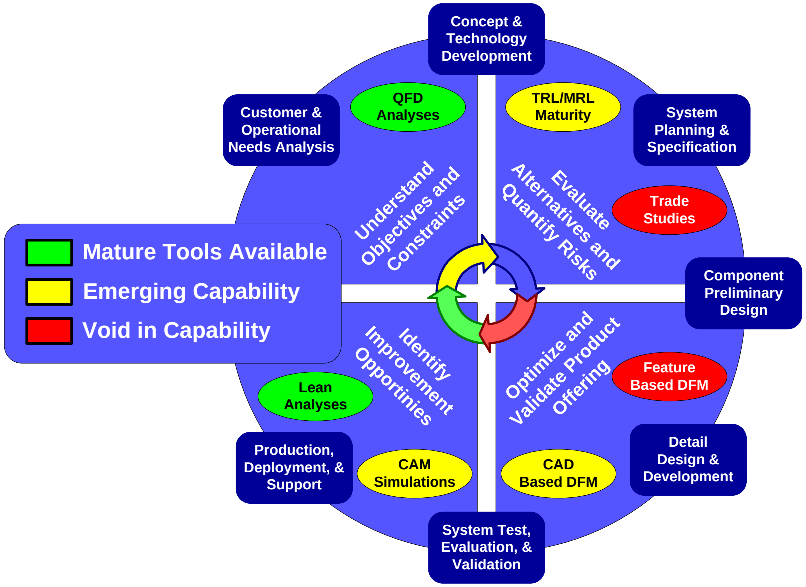
NDIA NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

Current State of Producibility M&S

- **Many producibility issues driven by early SE & design decisions**
  - Producibility forgotten requirement
  - Producibility hard to quantify early
  - Producibility M&S tools immature
- **Most producibility analyses are CAD-based rule checkers**
  - Require nearly final design layout
  - Occur too late to influence design
  - Only as good as rules loaded in
- **Need quantitative low & high-fidelity tools for trade studies**
  - Balance performance/producibility
  - Guide analysis-based decisions
  - Shape design vs. verify problems

Systems Engineering Process

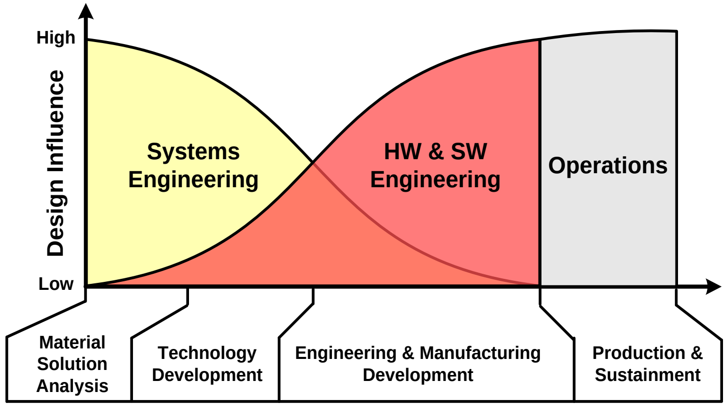


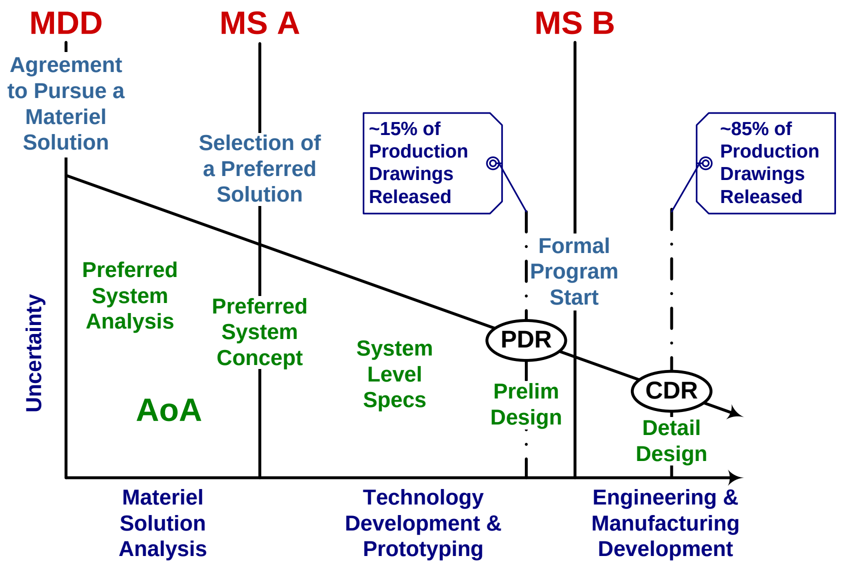


Void Exists in Current Producibility M&S Capabilities

JCSEM Committee Objective

- **Overall JCSEM Mission**
  - **Integrate manufacturing and producibilty considerations into early systems engineering activities**
- **Policy sub-committee charter**
  - **Identify and update key SE policy documents to drive early focus on manufacturing & producibility**
- **People sub-committee charter**
  - **Identify critical producibilty engineering skills required for early manufacturing engagement in SE**
- **M&S sub-committee charter**
  - **Identify industry M&S analysis needs required to address producibility concerns in early design activities**





Goal is to Move Manufacturing to the Left in Acquisition

JCSEM M&S Sub-Committee Scope

"Identify industry M&S ***analysis*** needs to facilitate the integration of producibility concerns into the earliest phases of the system engineering process"

In-Scope:

- **Product & process centric analyses to guide design decisions**
- **Factory & supply chain analyses to guide industrial base design**
- **Methodologies to integrate producibility into SE trade studies**

Out-of-Scope:

- **Virtual collaboration tools and enhancements to existing software**
- **Data standards, protocols, and interoperability requirements**
- **Digital/IT type solutions to facilitate information sharing**

Focus is Identifying M&S Needs that do not Exist Today

Sub-Committee Technical Approach

- **Objectives and Focus Areas**
  - Identification of product, process, and supply chain analysis needs
  - Identification of a producibility figure of merit “goodness” measure
  - Identification of viable approaches for SE trade study integration

- **Technical Approach**
  - Identify the key inputs that would go into a producibility figure of merit calculation to capture and quantify producibility concerns
  - Identify specific M&S focus areas where producibility analysis capabilities are needed to support system design activities
  - Define what type of information the analyses should provide at each step in the system design and development process
  - Identify potential system trade study approaches that enable producibility evaluations to be integrated into design activities

Goal is to Provide Investment & Implementation Guidance

Producibility Figure of Merit Elements

- **Producibility definition used by sub-committee:**
  - **Producibility defined as ease and economy of manufacturing an item, or group of items, in large quantities in a production environment**
  - **Most producibility costs "hidden" in nature such as scrap, rework, missed deliveries, safety stock, and lead time buffers due to low yield**

	Key Factory Metrics			
Producibility Life Cycle Cost Drivers	Cost	Quality	Delivery	Inventory
Unit Product Cost (Material & Conversion)	X			
Manufacturing Capital Investment Cost & Risk	X	X	X	
Development MRL Maturation Cost & Risk	X	X	X	
Overall Manufacturing Cycle Time (WSCT)			X	X
Item Scrap & Rework (COPQ)	X	X		
Item Rate & Shipment Risks (OTTR)			X	X
Item Assembly, Test, & Integration Complexity	X		X	
Item Long Term Sustainability Risks	X	X	X	X

Legend
Manufacturing Cost Currently Considered
Manufacturing Cost not Currently Considered
Hidden Factory Cost not Currently Considered

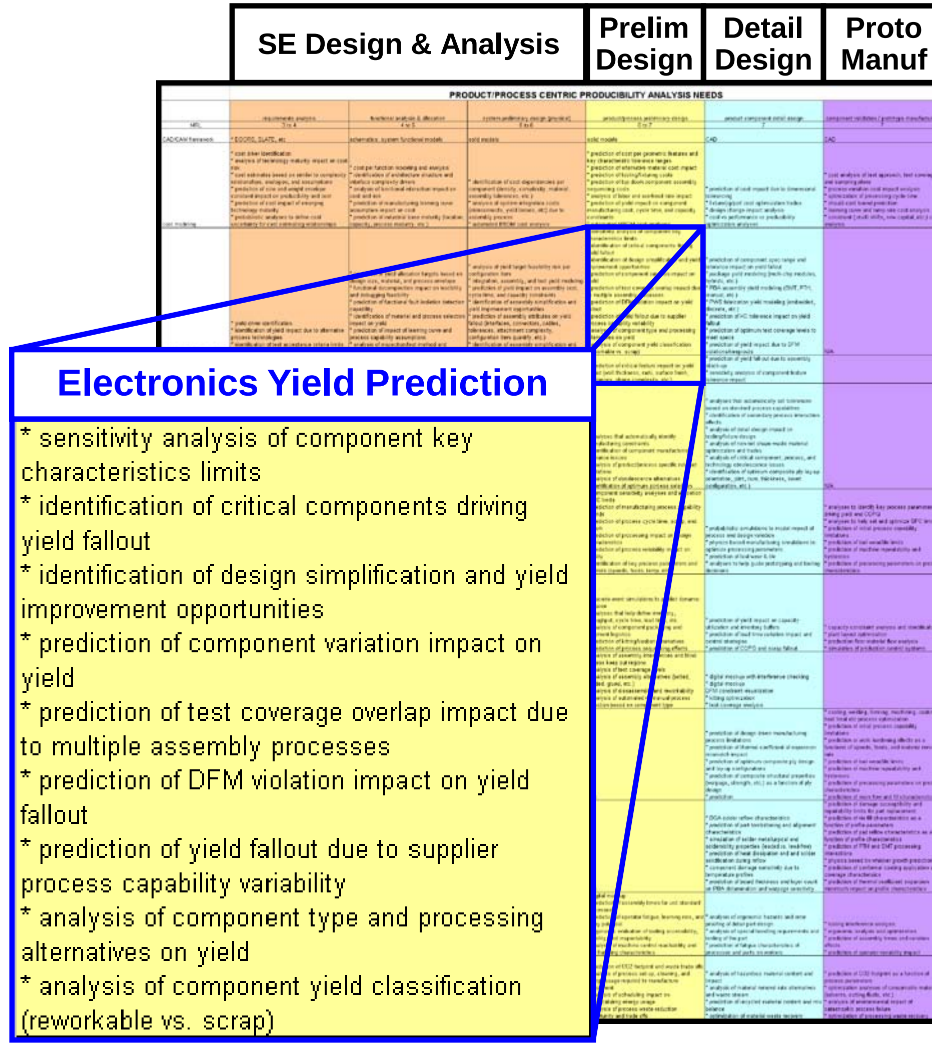
Weight factors would be assigned to each element of the figure of merit based on relative cost impact and risk for critical systems, sub-systems, & components

Figure of Merit Links Producibilty to Key Factory Metrics

Product & Process Centric Analyses

Matrix focus areas:

- Should cost analyses
- Yield prediction models
- DFX analyses
- Manuf process modeling
- Production line modeling
- Physics based analyses (casting, solder flow, etc.)
- System integration, assembly, & test modeling
- Operator assembly & test modeling, e.g., ergonomics
- Obsolescence modeling

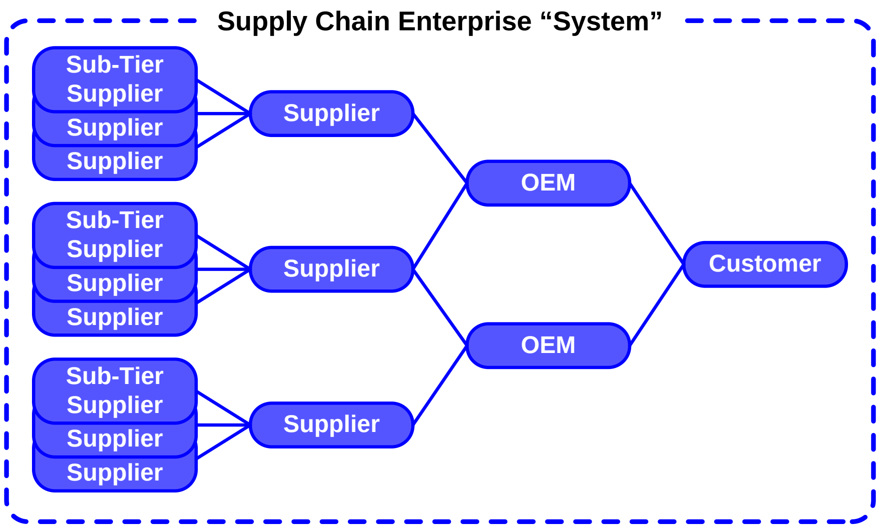


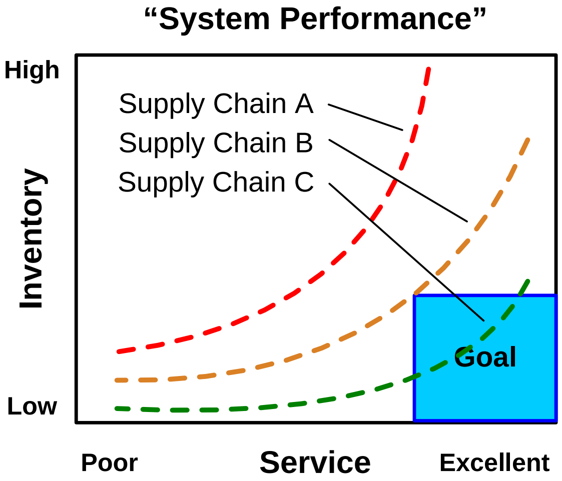
M&S Analysis Output for each Design Phase Identified

Supply Chain Design & Analyses

Analysis focus areas:

- Distribution aspects
  - Infrastructure complexity
  - Business strategy alignment
  - Logistics/queuing delays
  - Environmental events
- Technical aspects
  - Product complexity
  - Material availability/maturity
  - Process learning curves
  - Technology maturity
  - Work force maturity
  - Sustainability impact
  - Contract/policy constraints
  - Trend analysis & diagnostics





System Modeling Approach for Industrial Base Design

Producibility M&S Linkage

	Product, Process, & Supply Chain Producibility Analysis Tools										
Producibility Life Cycle Cost Drivers	Should Cost Modeling	Yield Modeling	DFX Analyses	Process Modeling	Production Line Modeling	Physics Based Process Simulations	System Integration Assembly & Test Modeling	Operator Assembly & Test Modeling	Obsolescence Modeling	Supply Chain Design & Performance Modeling	Supply Chain Trend Analysis & Health Monitoring
Unit Product Cost (Material & Conversion)	■			■		■					
Overall Manufacturing Cycle Time (WSCT)					■						
Item Scrap & Rework (COPQ)		■	■			■					
Item Rate & Shipment Risks (OTTR)		■	■		■		■			■	■
Item Assembly, Test, & Integration Complexity							■	■			
Item Long Term Sustainability Risks									■		■
Development MRL Maturation Cost & Risk	Program Planning & Risk Management Tools & Approaches Apply Here										
Manufacturing Capital Investment Cost & Risk											

Legend
Manufacturing Cost Currently Considered
Manufacturing Cost not Currently Considered
Hidden Factory Cost not Currently Considered

Weight factors would be assigned to each element of the figure of merit based on relative cost impact and risk for critical systems, sub-systems, & components

Producibility Figure of Merit Integrates M&S Tool Output into a Single "Goodness" Measure for Trade Evaluations

SE Trade Study Integration

- **Manufacturing VOC to be included in trade study process**
  - Responsible for long-term production of the proposed system
  - Provides input on production cost, quality, delivery, & inventory goals
  - Establishes process capability, cycle time, and yield flow down targets
- **Quality Function Deployment (QFD) based methods**
  - Most common trade study tool to down select alternative concepts
  - Help translate customer needs into system specs and design criteria
  - Correlate key technical performance measures to acquisition cost
  - Mature approach that can be easily adapted to include producibility
- **Value Driven Design (VDD) based methods**
  - Integrates systems engineering, optimization, and economic principles
  - Leverages requirements flexibility, optimization, and value models
  - Helps balance among competing TPM's to produce best system offering
  - Emerging research area that addresses limitations of QFD approaches

Producibility M&S Capability Enables Trade Integration

DoD and Industry Benefits

- Several GAO studies conducted around acquisition cost overruns
  - Systemic issue was excessive design, technology, & manufacturing risk
  - Successful programs exhibited earlier design & producibility knowledge
  - Recommendation is adoption of knowledge-based decision processes

- Producibility analysis capability generates critical knowledge early
  - Provides means to influence and validate requirements feasibility
  - Provides means to identify, quantify, and proactively plan for risk
  - Provides manufacturing analysis capability comparable to engineering

- Producibility figure of merit provides means to quantify concerns
  - Provides means to quantify "hidden costs" during early design studies
  - Provides means to guide industrial base solutions and minimize risk
  - Provides means to down select most producible design alternatives

Producibility M&S Enabler for Early Knowledge Integration

Summary & Recommendations

- **Producibility is neglected "ility" due to lack of analysis capability**
  - **Producibility issues are difficult to predict and drive "hidden" costs**
  - **Manufacturing VOC needs to be included in requirements definition**
  - **SE trade studies need to incorporate producibility considerations**
- **Producibility M&S is a critical research area that has been missing**
  - **M&S tools required to drive manufacturing to left in acquisition**
  - **Product, process, & supply chain centric analyses are needed**
  - **Requires focused research attention and investments to mature**
- **Top level framework established for SE trade study integration**
  - **Producibility figure of merit developed as "goodness" measure**
  - **Current QFD-based methods can be extended to address producibility**
  - **More research is needed to develop and mature VDD-based approaches**

Final Report to Document Committee Recommendations

Applications in Integrated Diagnostics

12th Annual Systems Engineering Conference

29 October 2009

San Diego, CA

Authors: Tim Palmer and Jimmy Simmons

Overview

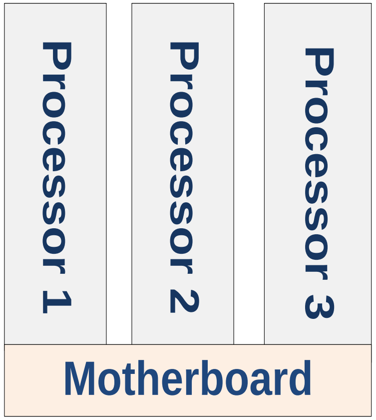
1. System Overview
2. Motivation
3. Problem Statement
4. Approach
5. Results
6. Conclusion

Overview

1. **System Overview**
2. Motivation
3. Problem Statement
4. Approach
5. Results
6. Conclusion

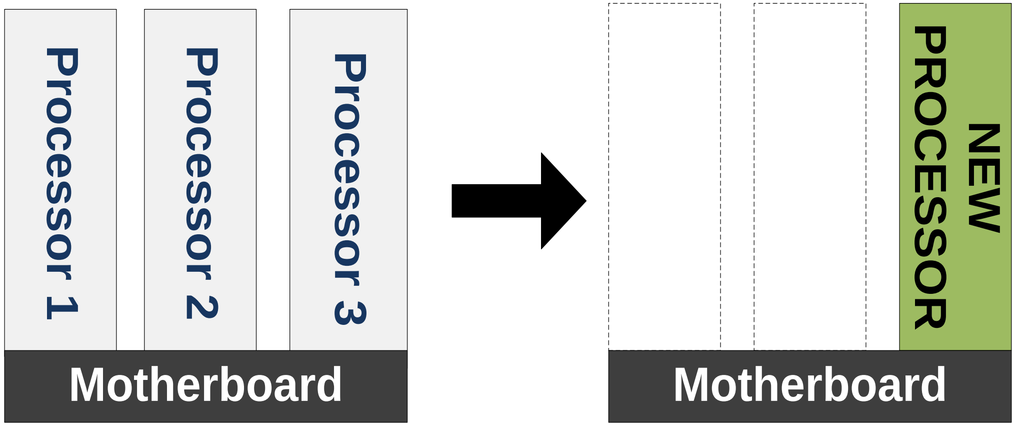
1. System Overview
Project Overview

- Legacy Problems
  - Limited Memory
    - Difficult to add new features
    - Maintained multiple code baselines to support different platforms
      - Adds more testing and development
  - Slow Processors
    - System could not process more data

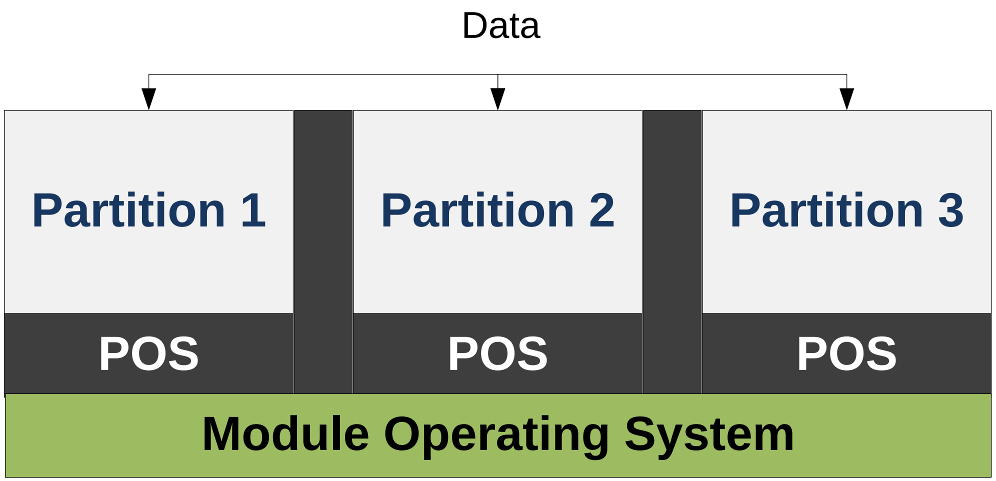


1. System Overview
Project Overview (Cont.)

- Project Description
  - New Hardware
    - Faster processor
    - More memory
    - Added Ethernet
  - Port legacy software
    - Interrupt system to polling system
    - Addition of a partitioned RTOS

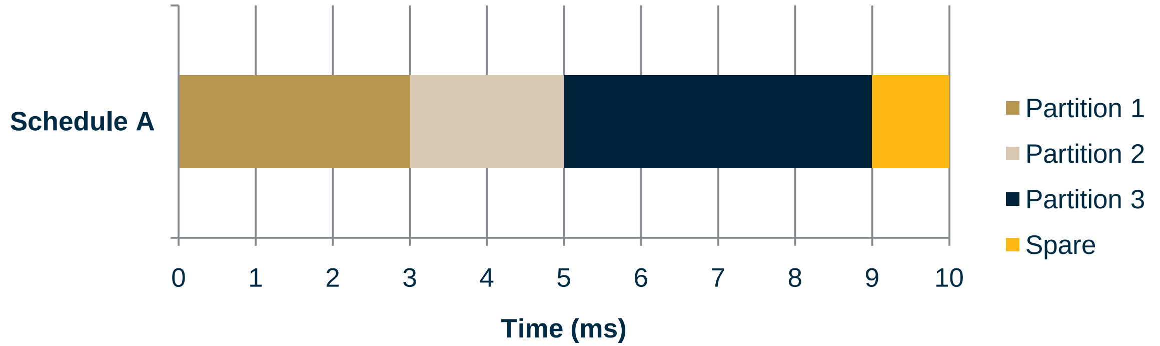


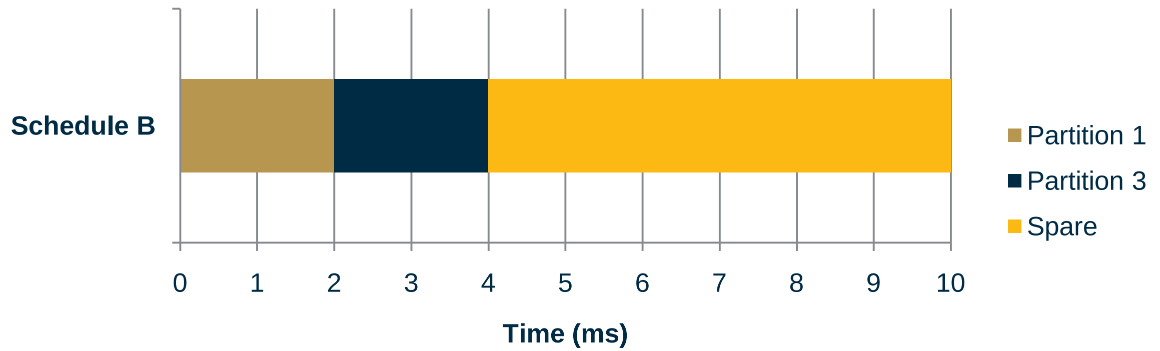
1. System Overview
Partitioned Operating System (OS)



- Only one partition may run at a time
- Data can move between partitions when defined by OS

1. System Overview
Partitioned OS (Cont.)





- **Different schedules allow different Partitions to run when needed**

1. System Overview
Internal Interfaces

- Ports – Calls through the OS
  - Queuing ≈ 80 µs for read/write access
  - Sampling ≈ 50 µs for read/write access
- Shared Memory - Directly accessible by the partition
  - ≈ 10 µs for read/write access

* Numbers vary based on hardware or the RTOS

1. System Overview
External Interfaces

Interface	Speed	Usage
Ethernet	10/100 Mbps	Net loading code into RAM
1553	1 Mbps	Communication with other systems and Instrumentation Data
RS-232	115.2 Kbps	Starting a net load and Default printf
RS-422	9.6 Kbps	Legacy debug

Overview

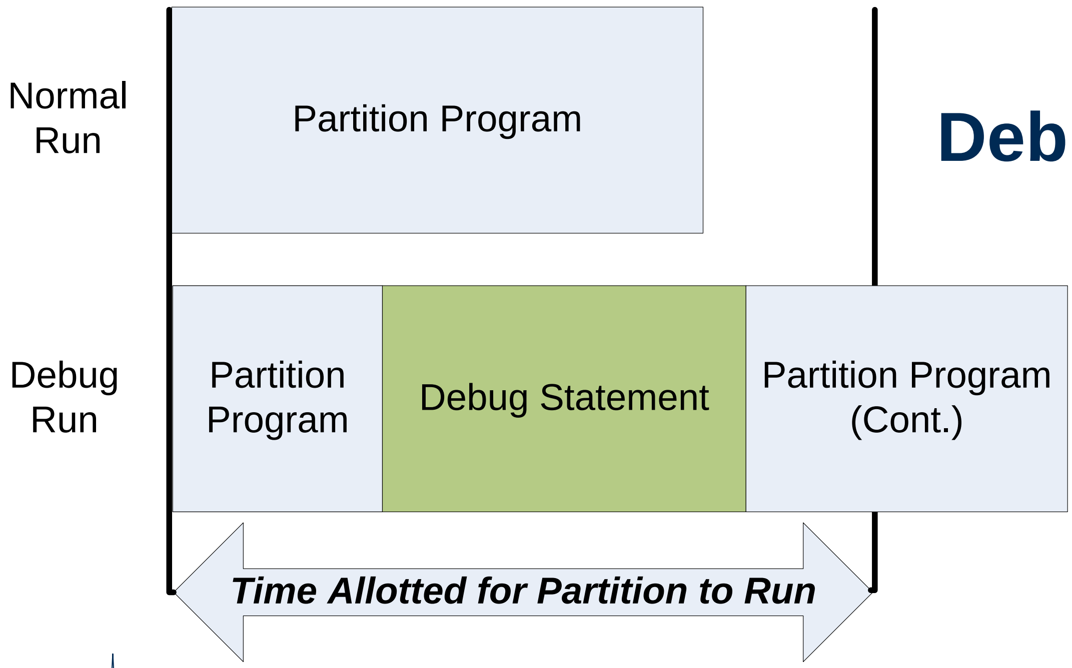
1. System Overview
2. **Motivation**
3. Problem Statement
4. Approach
5. Results
6. Conclusion

2. Motivation
General Debugging: Single Partition

Partition time allotted: 1 ms

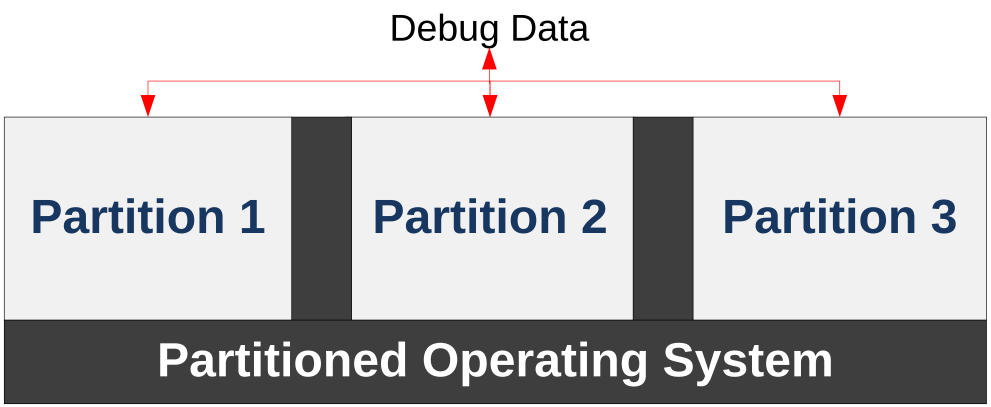
<u>Partition time used: 800µs</u>

Partition time unused: 200µs



Debug statements: ≈ 300 µs

2. Motivation
General Debugging: Multiple Partitions



- **Multiple partitions used the same debug media**
  - **Data overwrites**
  - **Debug stream contention**

2. Motivation
System Performance

- System limitations
  - Processor/memory utilization during normal operation
- System throughput
  - Amount of system inputs
- System latency
  - Response time to system inputs
- System data flow
  - Understanding how information gets from point A to point B within system

Overview

1. System Overview
2. Motivation
3. **Problem Statement**
4. Approach
5. Results
6. Conclusion

3. Problem Statement

- Avoid Uncertainty Principle
  - Latency introduced by diagnostics drastically affecting system
- Provide as much information as possible
- Introduce as little system interference as possible
- Provide information that is easy for user to understand and analyze
- Scalable for future use

Overview

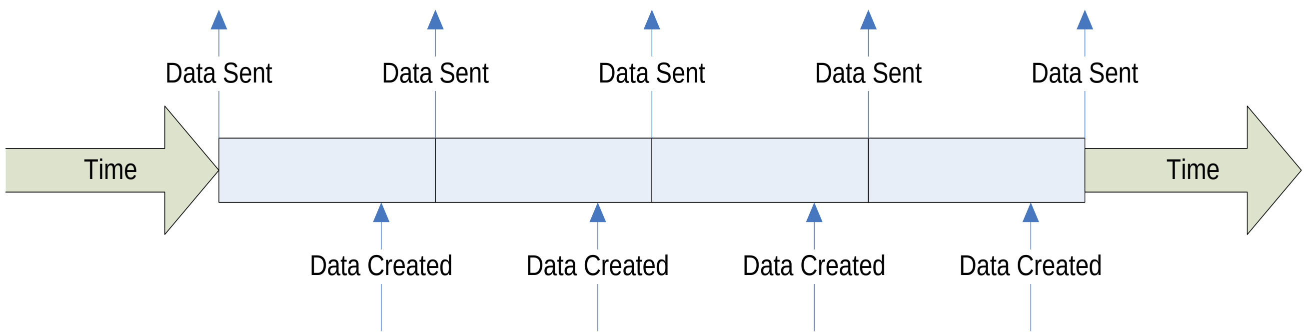
1. System Overview
2. Motivation
3. Problem Statement
4. **Approach**
5. Results
6. Conclusion

4. Approach
Interface

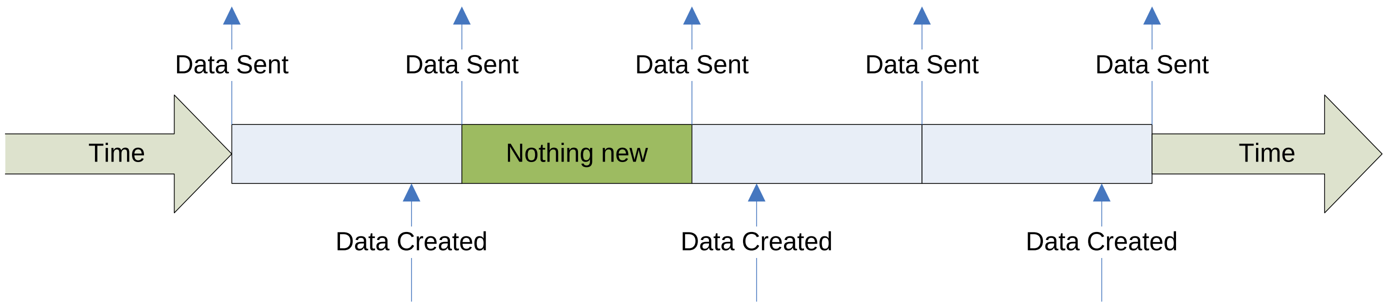
- Ethernet
  - High bandwidth
- PC Graphical User Interface
  - Real time display
  - Bit/Byte analyzer
  - Raw/Parsed/Filtered Data
- Storage for post-analysis

4. Approach
Rate

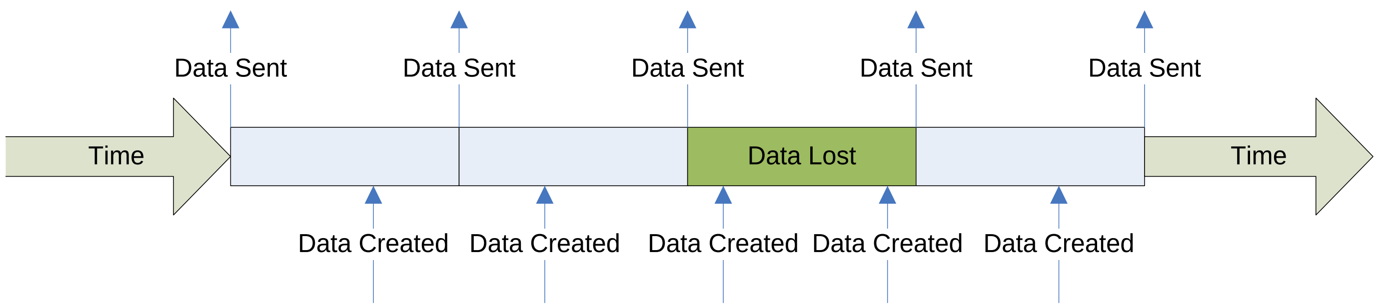
- Internal and External considerations
- External Design Considerations
  - How often is data required to debug?
  - How much data is required to debug?



4. Approach
Rate (Cont.)

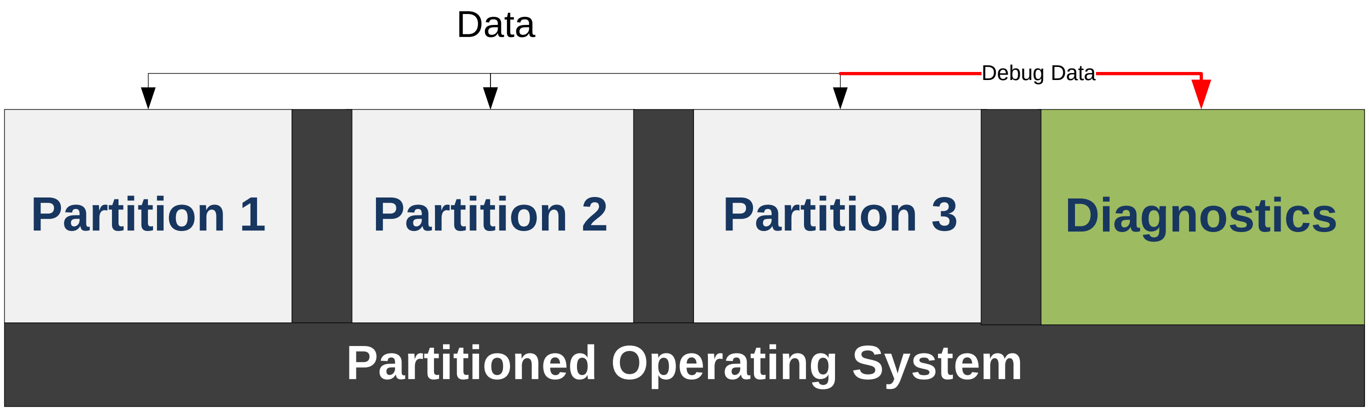


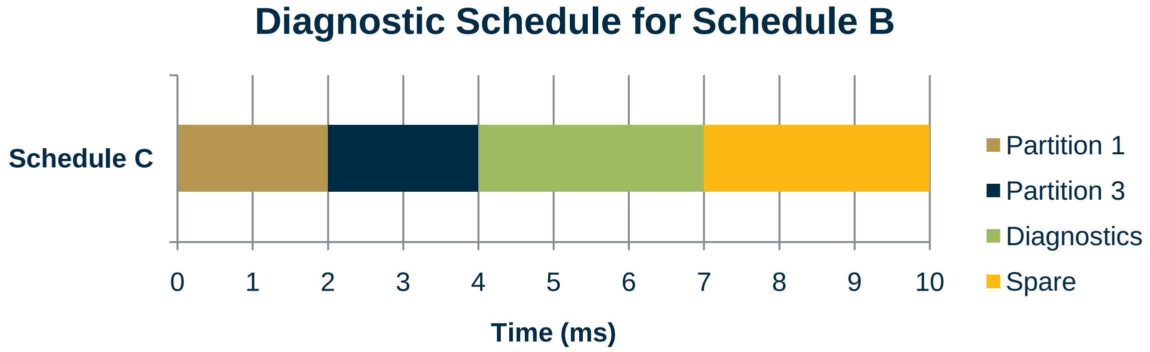
Less debug data created than possible
(Is there enough data to debug?)



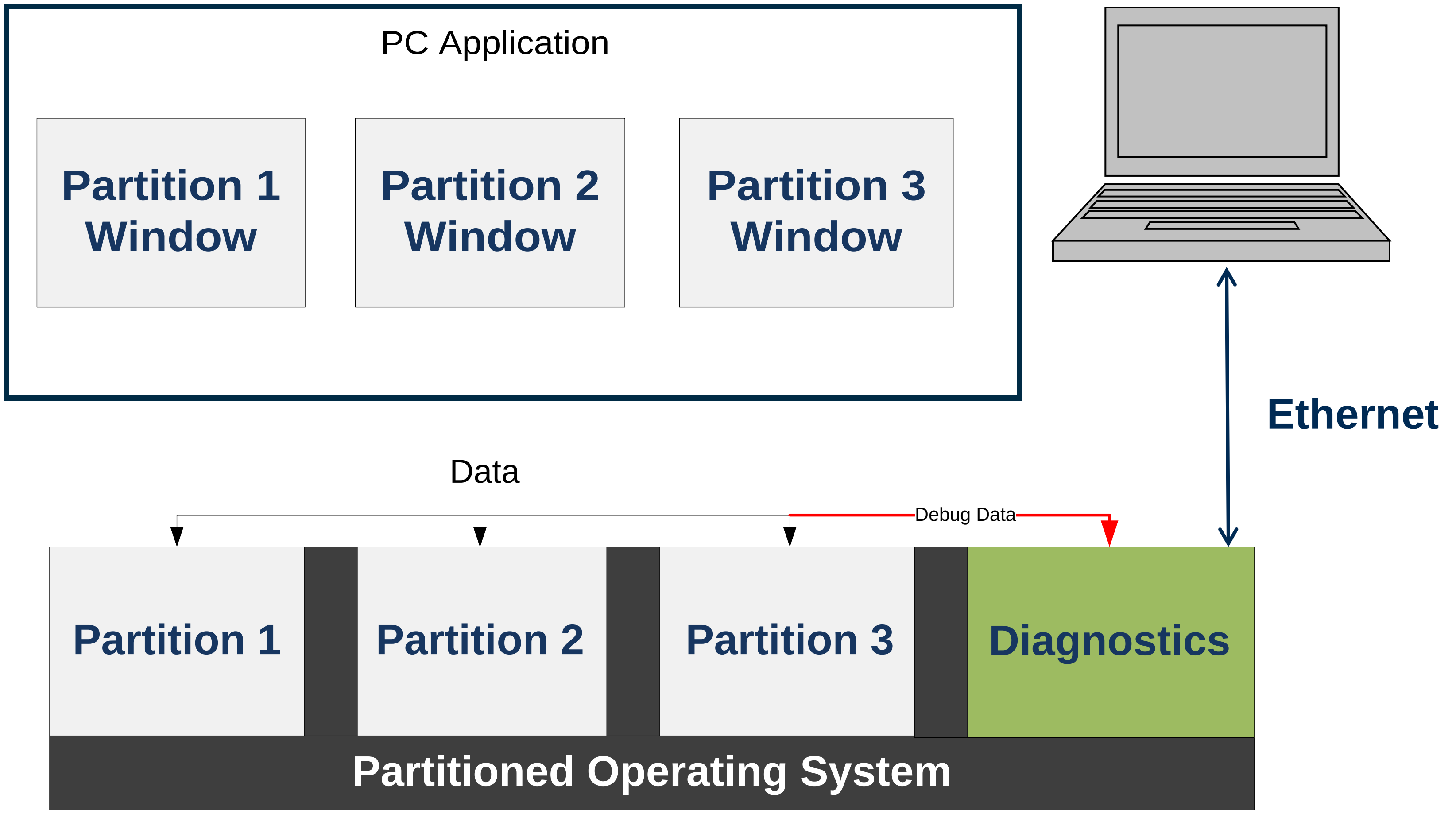
Too much debug data created

4. Approach
Diagnostics Partition





4. Approach
Diagnostics Application

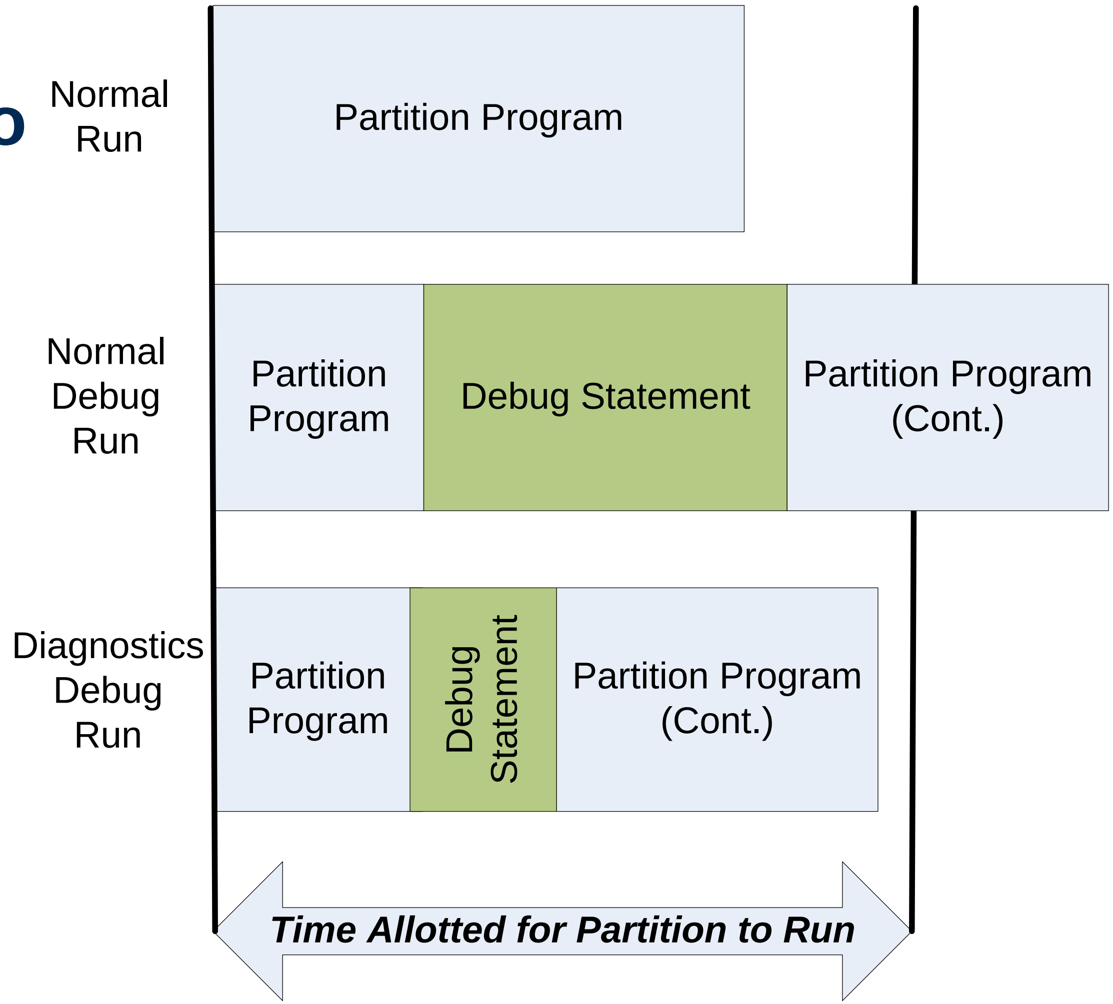


Overview

1. System Overview
2. Motivation
3. Problem Statement
4. Approach
5. **Results**
6. Conclusion

5. Results
Debugging with Diagnostics

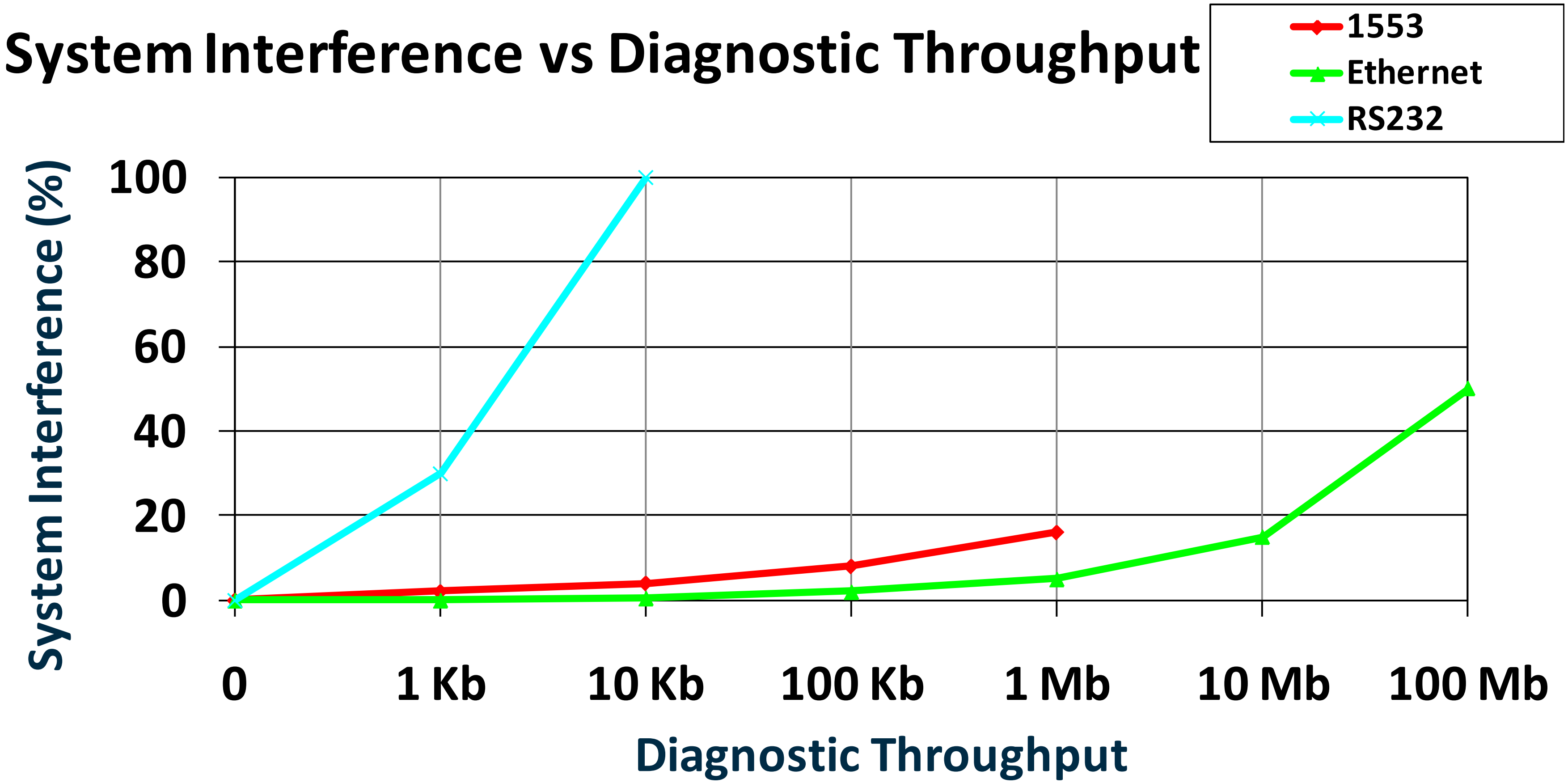
- **Diagnostics Debug statements found to take ≈ 10 μs**
- **Partition allotted 1 ms to run**



5. Results

- Found bugs during overnight test cases
- Processor utilization spikes in overnight test cases
- Queue trickling and data buffer overflows
- Other general diagnostic data during normal operation
- Possibilities for optimization
- Requirements verification
- Seeing the inner workings of the system with limited system interference

5. Results



System Interference vs Diagnostic Throughput
1553
Ethernet
RS232
System Interference (%)
100
80
60
40
20
0
0
1 Kb
10 Kb
100 Kb
1 Mb
10 Mb
100 Mb
Diagnostic Throughput

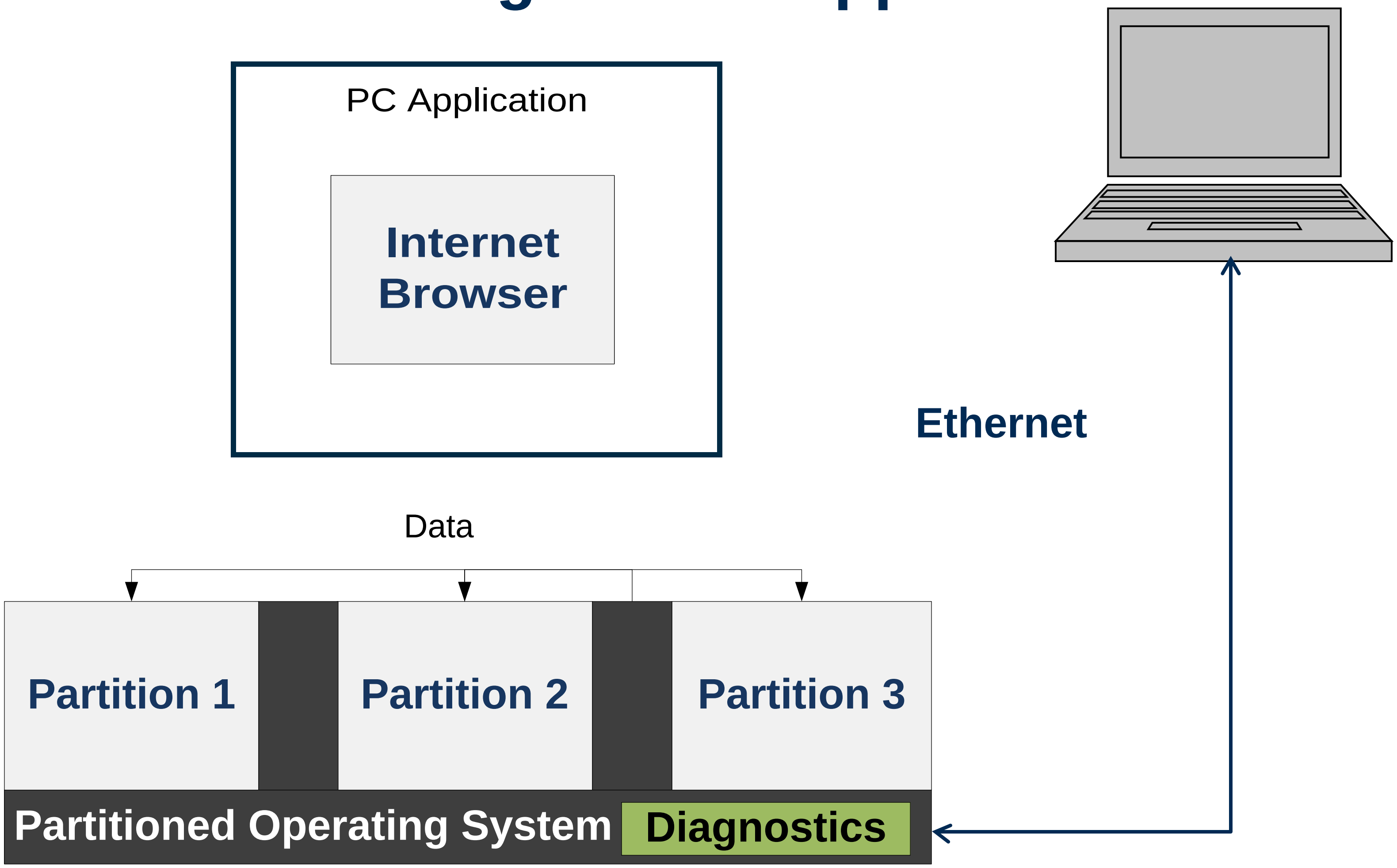
Overview

1. System Overview
2. Motivation
3. Problem Statement
4. Approach
5. Results
6. **Conclusion**

6. Conclusions

- Lessons learned
  - Keep interface simple for ease of use
  - Make Ethernet output multicast or UDP
- Future ideas
  - Move Diagnostics partition to an RTOS Task to reduce latency and increase throughput
  - Make the interface for partitions more abstract for scalability
  - Work with developers and testers for more synergy in using tool

6. Future Approach
Diagnostics Application



Disclaimer

The Opinions Expressed by the Speaker

Are His Own

and

Do Not Necessarily Reflect Anyone Else's

..although

They Might!

The Power of the Spec:

The Many and Diverse Roles of Specifications & Standards in Systems Engineering

Robert B. “Scott” Kuhnen

HQ AFMC Command Stdzn Office

Wright-Patterson AFB OH

28 October 2009

First…some table setting…

déjà vu for any of you?

Any of you here in 2007?

Any of you remember…

..this outfit?

How to Paint a Room

The Role of Specs & Standards in the Systems Engineering… ..Business!

Robert B. “Scott” Kuhnen

ASC/AFRL Eng Stds Office

Wright-Patterson AFB OH

24 October 2007

Shall We Get Started?

Not so fast!!!

- “Proper interior paint preparation of your walls and ceilings before painting will often encompass more work than the actual painting. Up to 75% of the work can be getting a surface ready for painting.”

- Karl Crowder
- http://www.house-painting-info.com/index.html

Tools for Prepping Walls

- Safety glasses or goggles
- Respirator or face mask
- Ear protectors
- Rubber gloves
- Pry bar
- Paint scraper
- Wallpaper steamer (rent if needed)
- Can opener or widening tool
- Fan
- Hand sanding block
- Orbital sander
- Screwdriver
- Putty knife
- Sponge
- Cap or scarf
- Old clothes







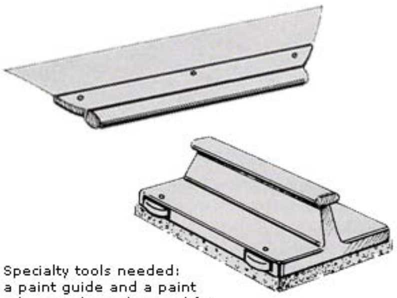
Materials for Prepping Walls

- Spackle (compound)
- Fine-grit sandpaper
  - (100 - 120-grit silicon carbide)
- Detergent and ammonia or tri-sodium phosphate (TSP)

- Self-adhesive drywall tape
- Primer or adhesive pad
- Sizing (for wallpapering)

Tools for Painting

- Drop cloths
- Ladders
- Buckets
- Paint edger
- Brushes, 4", 3", and 11/2"
- Angled sash brushes, 1 1/2" and 2"
- Roller pan with screen
- Roller covers with appropriate naps
- Roller handle
- Roller extender
- Paint guide

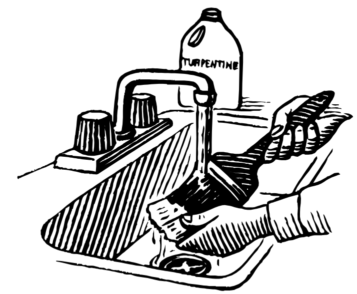


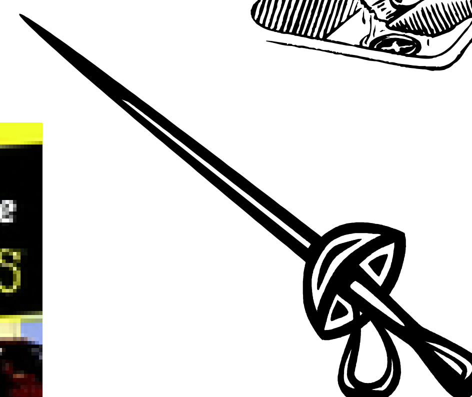
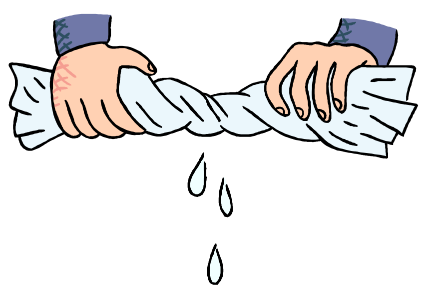
Specialty tools needed: a paint guide and a paint edger. Both can be used for "cutting in."

Materials for Painting

- Masking tape, 2" wide
- Newspaper
- Adhesive pad or primer
- Paint thinner (with oil-based paints)
- Aluminum foil
- Rags





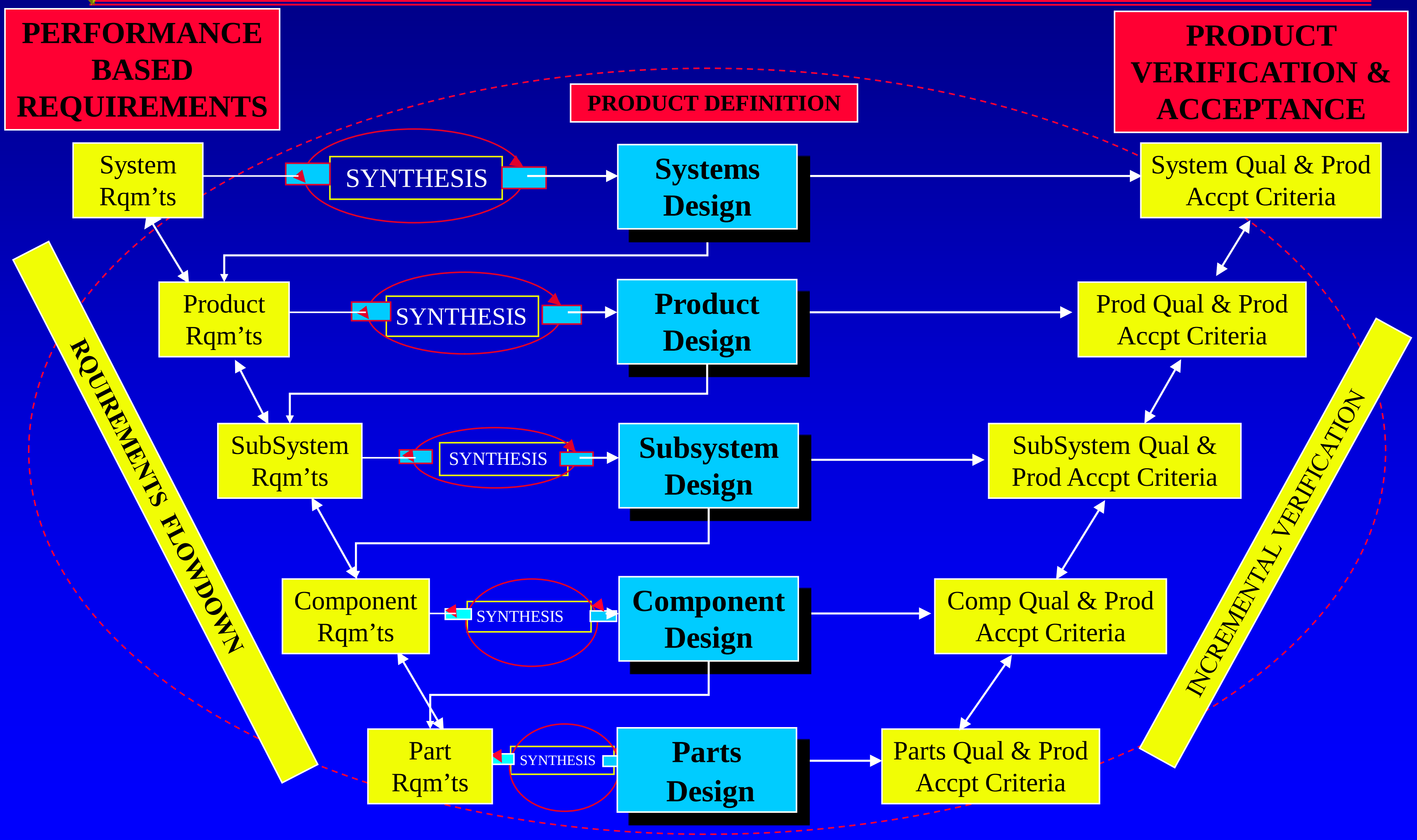




What the experts say…

- Most people think they know how to paint, and usually the results are pretty good. But for painting contractor John Dee, "pretty good" isn't good enough. After nearly three decades of rolling, brushing, and spraying paint he knows the subtle tricks for applying smooth, even coats to walls, ceilings, and woodwork, and for creating crisp boundaries between colors.

  According to Dee, there's no magic to getting professional-looking results. Practice helps, and thorough surface preparation is essential. But the key, he says, is to paint in an orderly, systematic way. So whether he's painting a multi-paneled door or a flat expanse of wall, he proceeds almost scientifically from one step to the next, with no shortcuts. "Your approach to the task, the order in which you do things, can speed the work or slow you down," Dee says. "Here's the approach that works best for me."

ENGINEERING DESIGN PROCESS



A Theory to Live By…

- Preparing the surface is the most important part of any painting project. If the paint doesn’t have a smooth, clean surface to adhere to, the result will be a poor-quality job that doesn’t last very long. “You should spend at least as much time on surface prep as you will be painting,” advises Horst.

- If it's worth doing, it's worth doing right the first time. And proper preparation is the key. Few of us really realize this, or even like to admit it, since it leads to more work. It is a step that is all too often left out, and the final job reflects its omission. It is too easy just to start painting and not go through the necessary prep steps. Indeed, for a while the paint job may even look pretty good. But sooner or later the poor quality will show up.

Talking about painting or…SE?

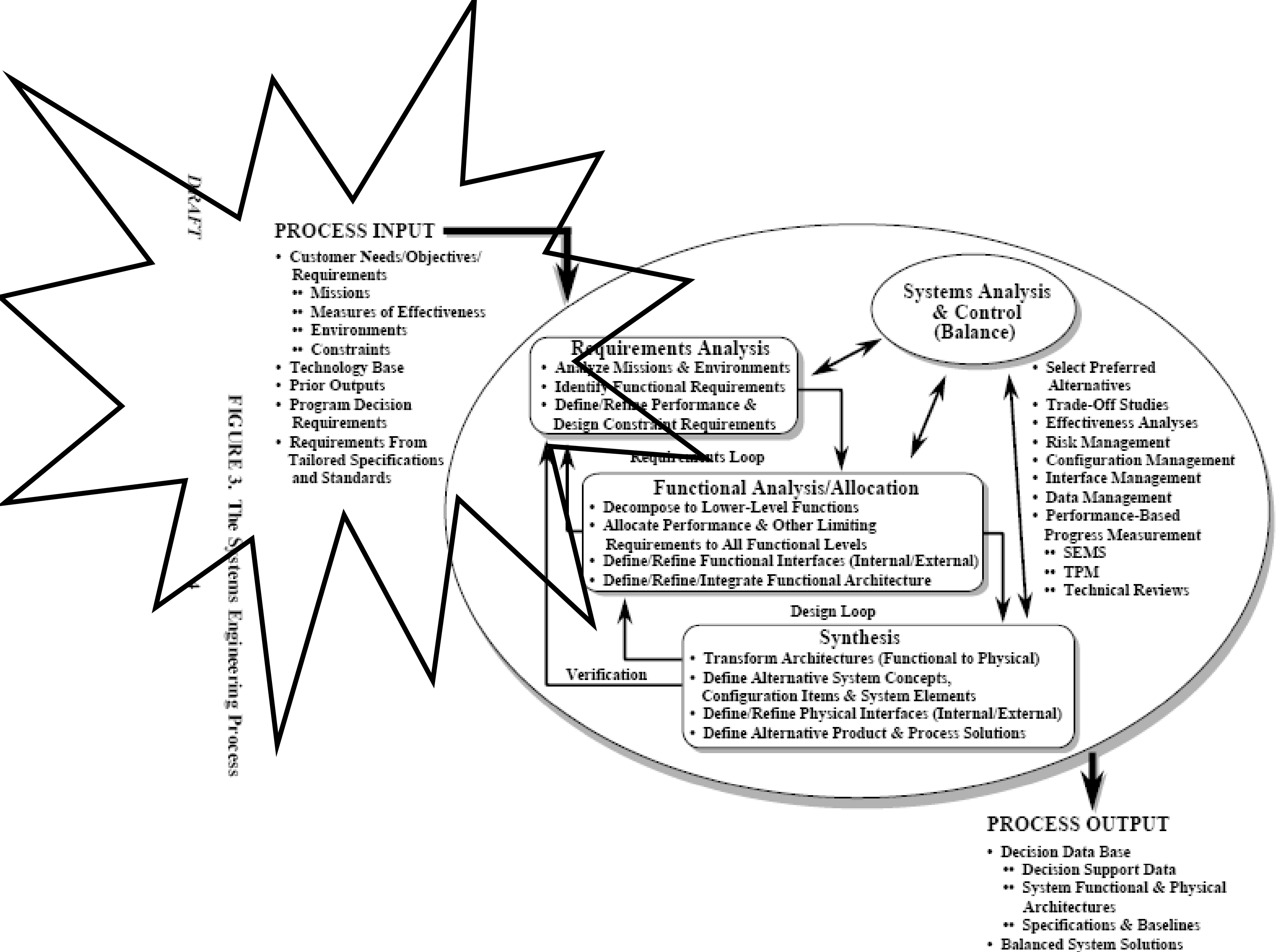
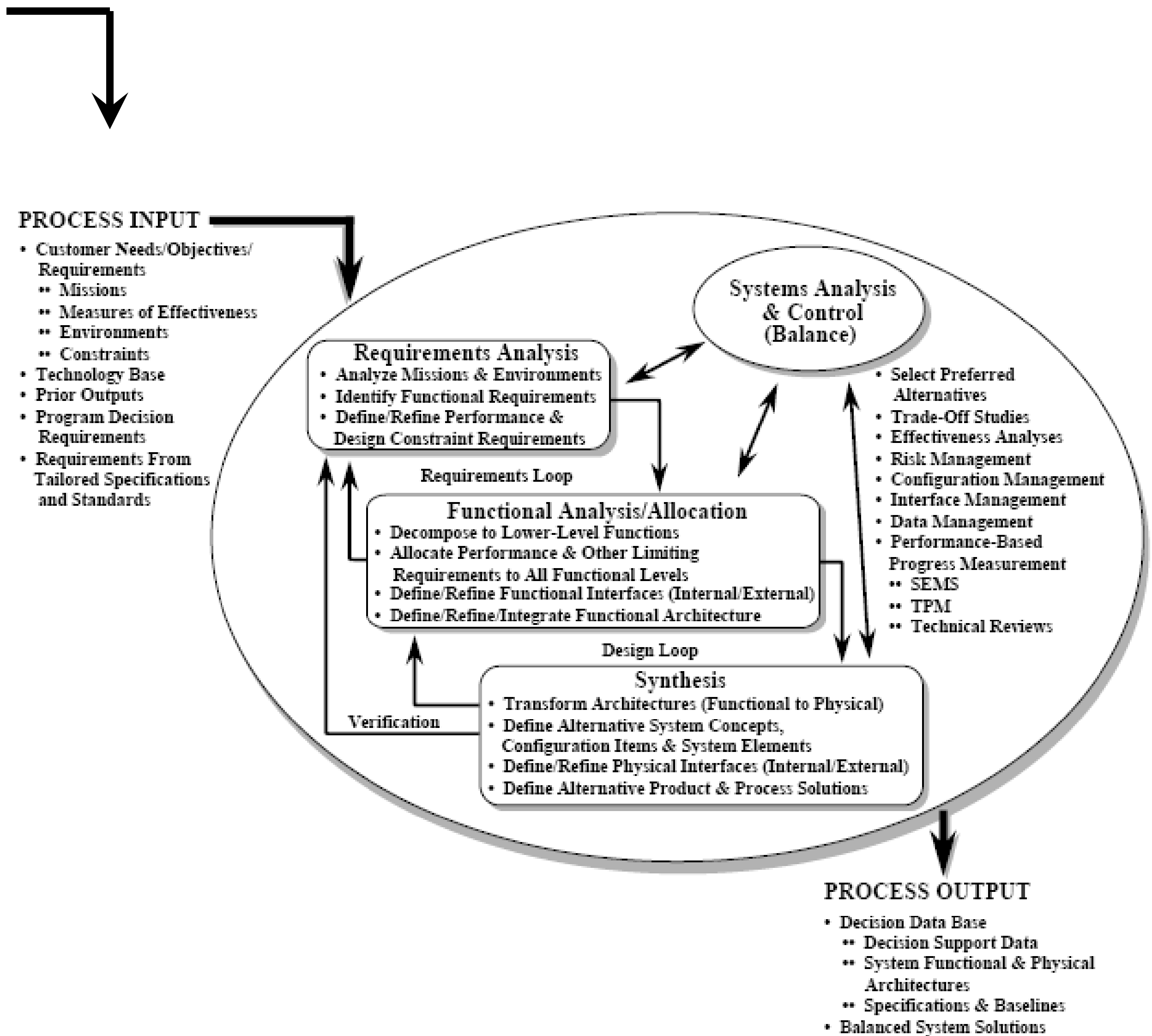


FIGURE 3. The Systems Engineering Process

- Defense Specifications
- Defense Standards
- Qualified Products Lists
- Non-Gov’t Standards
- Int’l Standards
- etc.



DRAFT

FIGURE 3. The Systems Engineering Process

4

MIL-STD-499B

DRAFT

DoD Systems Engineering Shortfalls*

- Root cause of failures on programs include:
  - Inadequate understanding of requirements
  - Lack of systems engineering discipline, authority, and resources
  - Lack of technical planning and oversight
  - Stovepipe developments with late integration
  - Lack of subject matter expertise
  - Availability of systems integration facilities
  - Low visibility of software risk
  - Technology maturity overestimated

Major contributors to poor program performance

* DoD-directed Studies/Reviews

Could the problem be…?

A PennWell Publication

Military & Aerospace ELECTRONICS™

Vol. 5, No. 9 | The Engineering Newspaper for the Worldwide Mil/Aero Electronics Industry | August 1994

Perry scraps mil-specs

By Bruce Rayner

WASHINGTON, DC—In late June, Defense Secretary William Perry ordered a dramatic about face in the Defense Department's use of military specifications and standards, ordering that all DoD programs rely more heavily on commercial parts and adopt a performance-based specification process.

While Perry's announcement was widely anticipated and publicly applauded by the defense electronics industry, many company officials are concerned that the changes will increase uncertainty in the acquisition process and threaten some existing systems that are operating well, such as the Qualified Manufacturing Line (QML), a DoD-specific system for certifying a manufacturing process.

"Right now it is a wait-and-see game," says Brad Paulsen, director of marketing for military and aerospace products at National Semiconductor (Santa Clara, CA). "There are a lot of issues that have not been clarified."

The directive, which will be phased in over the next six months, mandates that all DoD procurement contracts use commercial and industrial specs and standards where they exist; the use of mil-specs will require a waiver. Radiation-hardened components are exempt from the directive.

In another major change, program managers are now required to adopt performance-based specifications for new systems and major modifications. The performance specs describe how a system is to function but leaves the

(Continued on page 32)

Secretary of Defense William Perry has introduced far reaching changes to the procurement process, including mandating the use of performance specs.

Summary of the Weapon Systems Acquisition Reform Act of 2009:

- **Section 101. Systems Engineering Capabilities. The Defense Science Board Task Force on Developmental Test and Evaluation reported in May 2008 that "the single most important step necessary" to address high rates of failure on defense acquisition programs is "a viable systems engineering strategy from the beginning." The Government Accountability Office has reached similar conclusions. Unfortunately, the Committee on Pre-Milestone A and Early-Phase Systems Engineering of Air Force Studies Board of the National Research Council reported in February 2008 that the Air Force has systematically dismantled its systems engineering organizations and capabilities over the last twenty years. The other services have done the same. Section 101 would address this problem by requiring DOD to: (1) assess the extent to which the Department has in place the systems engineering capabilities needed to ensure that key acquisition decisions are supported by a rigorous systems analysis and systems engineering process; and (2) establish organizations and develop skilled employees needed to fill any gaps in such capabilities.**

Summary of the Weapon Systems Acquisition Reform Act of 2009:

- **Section 103. Technological Maturity Assessments.** For years now, the Government Accountability Office (GAO) has reported that successful commercial firms use a "knowledge-based" product development process to introduce new products. Although DOD acquisition policy embraces this concept, requiring that technologies be demonstrated in a relevant environment prior to program initiation, the Department continues to fall short of this goal. Last Spring, GAO reviewed 72 of DOD's 95 major defense acquisition programs (MDAPs) and reported that 64 of the 72 fell short of the required level of product knowledge. According to GAO, 164 of the 356 critical technologies on these programs failed to meet even the minimum requirements for technological maturity. Section 103 would address this problem by making it the responsibility of the Director of Defense Research and Engineering (DDR&E) to periodically review and assess the technological maturity of critical technologies used in MDAPs. The DDR&E's determinations would serve as a basis for determining whether a program is ready to enter the acquisition process.

Summary of the Weapon Systems Acquisition Reform Act of 2009:

- **Section 206. Acquisition Excellence.** The Department of Defense will need an infusion of highly skilled and capable acquisition specialists to carry out the requirements of this bill and address the problems in the defense acquisition system. The Committee has already established an acquisition workforce development fund to provide the resources needed to hire and retain new workers.

Bring me the head of a systems engineer!

- However, positive motivation is needed as much as money. Section 206 would address this issue by establishing an annual awards program – modeled on the Department's successful environmental awards program – to recognize individuals and teams who make significant contributions to the improved cost, schedule, and performance of defense acquisition programs.

Let's Give Awards!

Systems Engineering Fundamentals from Past Programs

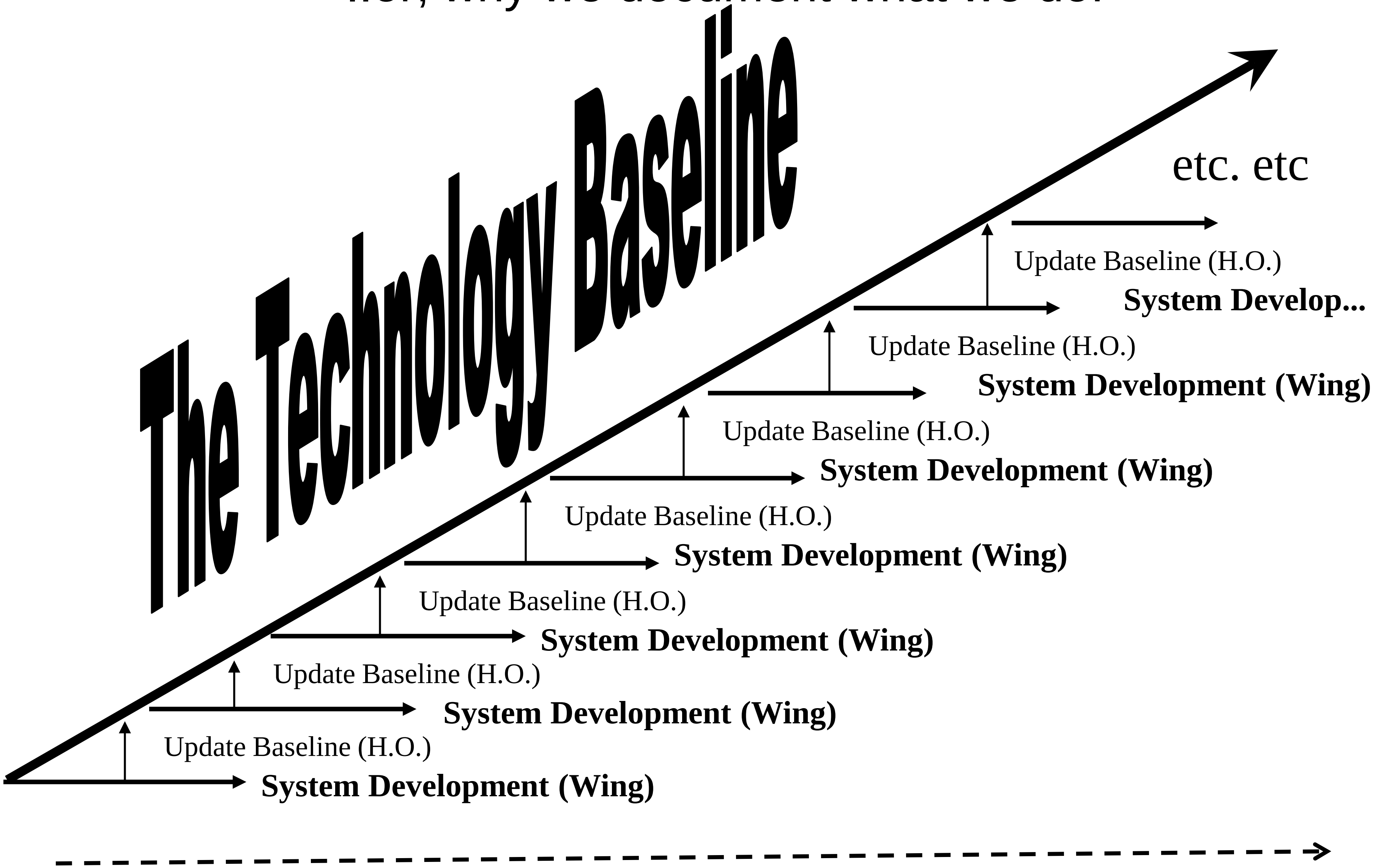
- SE was conducted by the design team
  - Systemic to the design process
  - Product of many designs by the same teammates over many programs and many years
- Common Characteristics: yesterday and today
  - Small, efficient systems engineering staff
    - Previous design engineers
      - Knack for requirements
      - Appreciated the larger challenge at the system level
  - Not always collocated and not always the same company

We don't "infuse" them; We GROW Them!

Source: Mr. John Griffin, former ASC/EN Director

How Knowledge Works…

..or, why we document what we do!

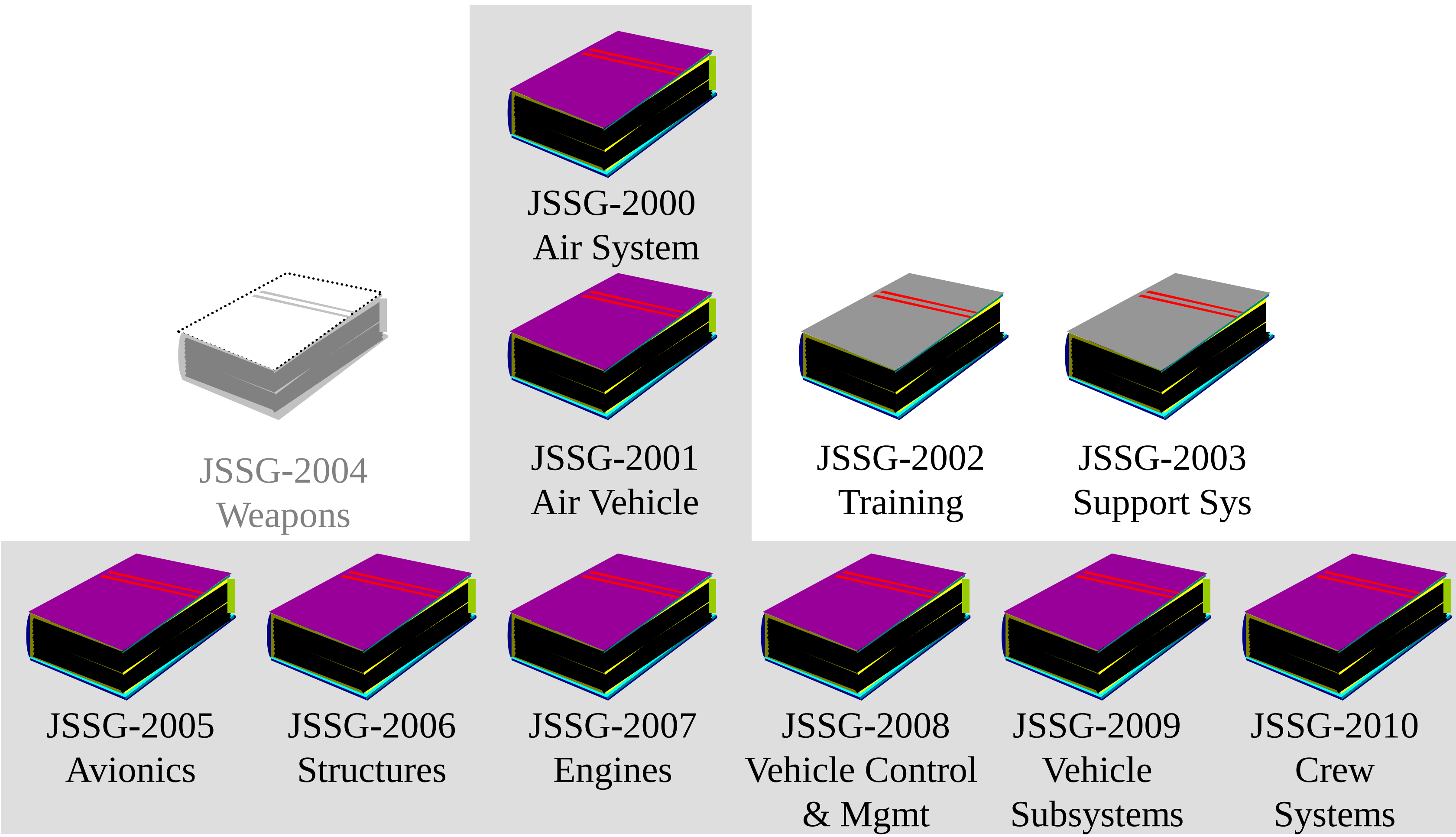


Time Line is measured in…decades!

Technical Wisdom From Our Past . . .

...Technical Leadership For Our Future

Joint Service Specification Guides



Unintended consequences?

A PennWell Publication
Military & Aerospace ELECTRONICS™
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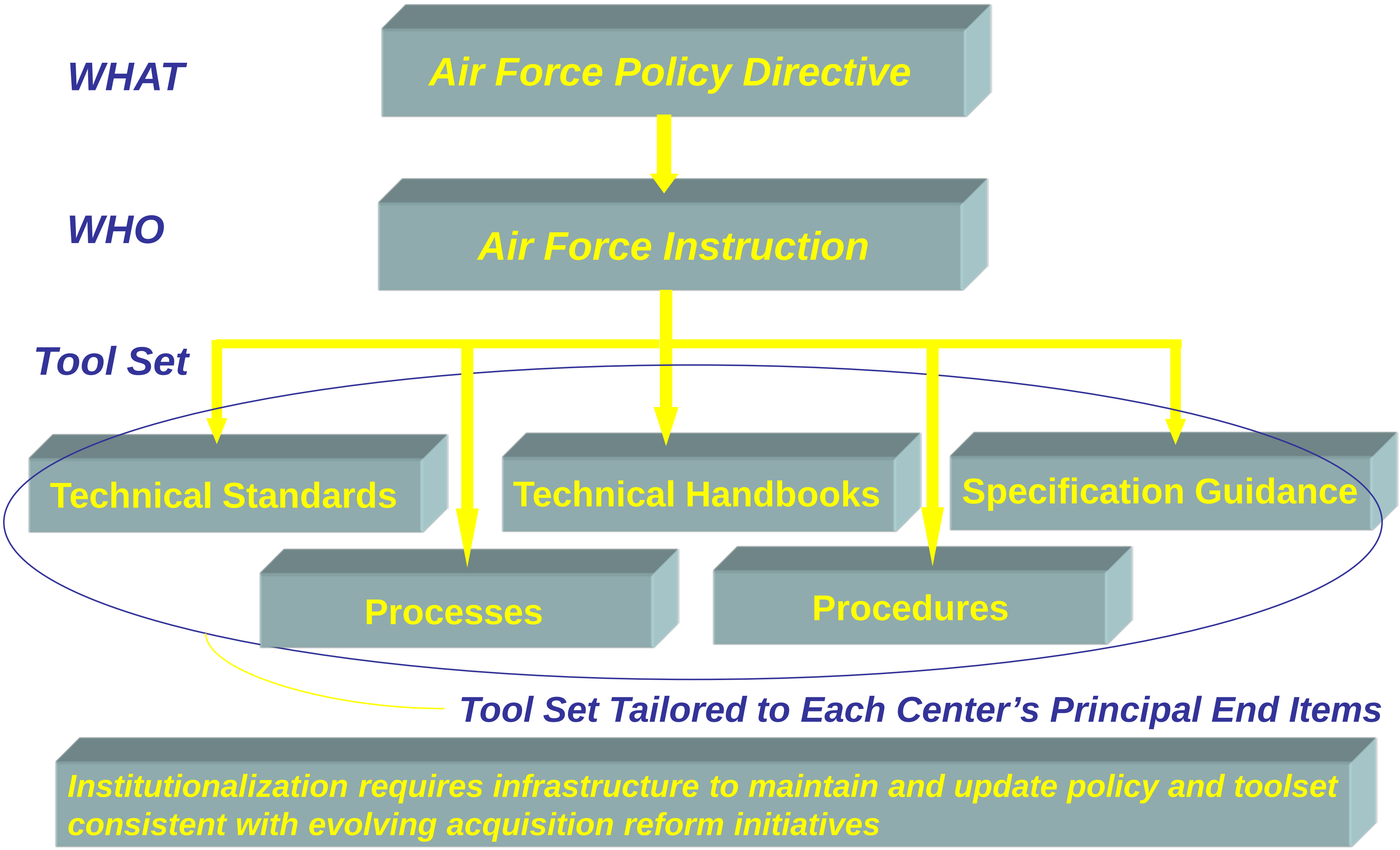
Secretary of Defense William Perry has introduced far reaching changes to the procurement process, including mandating the use of performance specs.

Truth is…we noticed issues almost immediately!

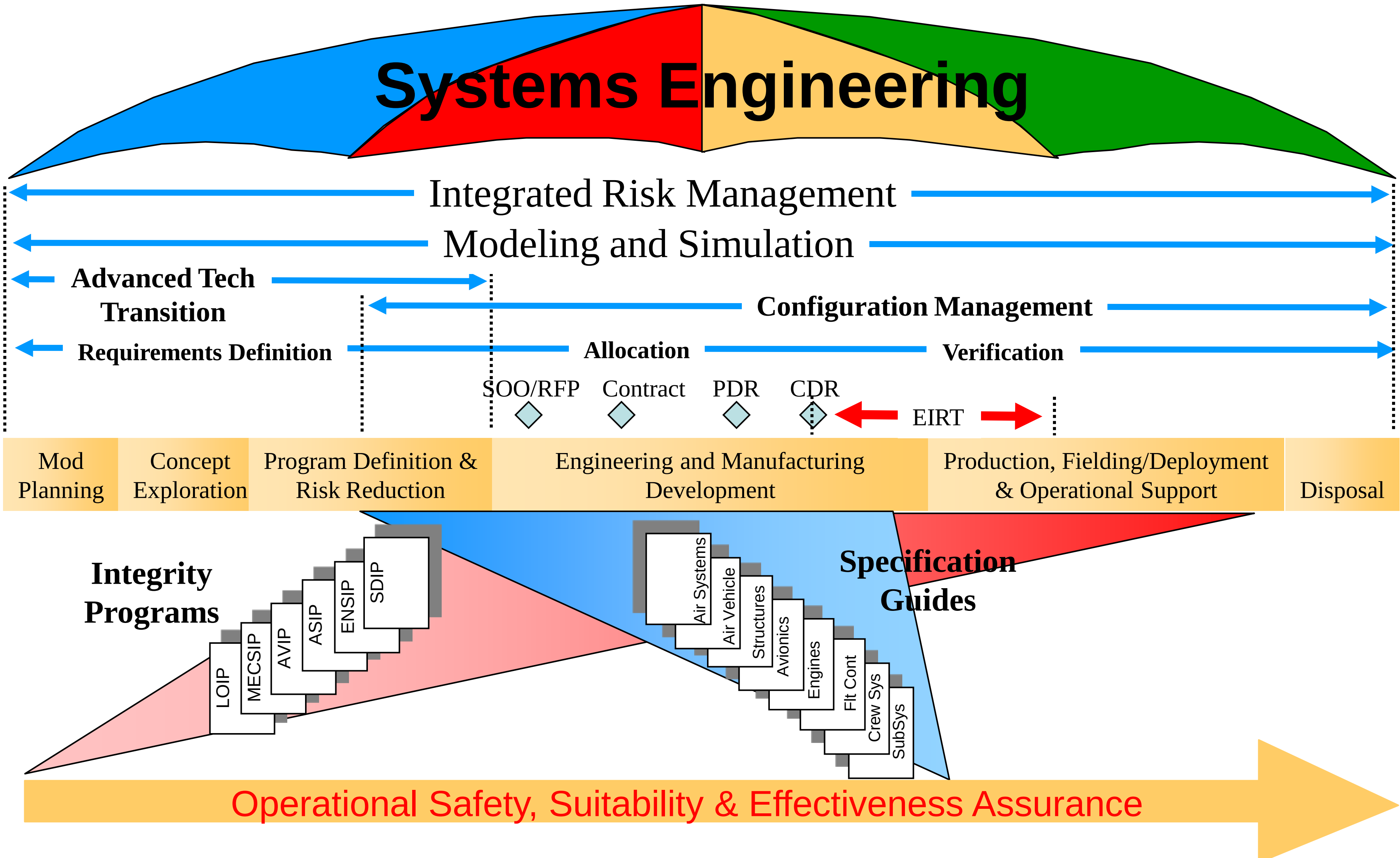
The Great Challenge

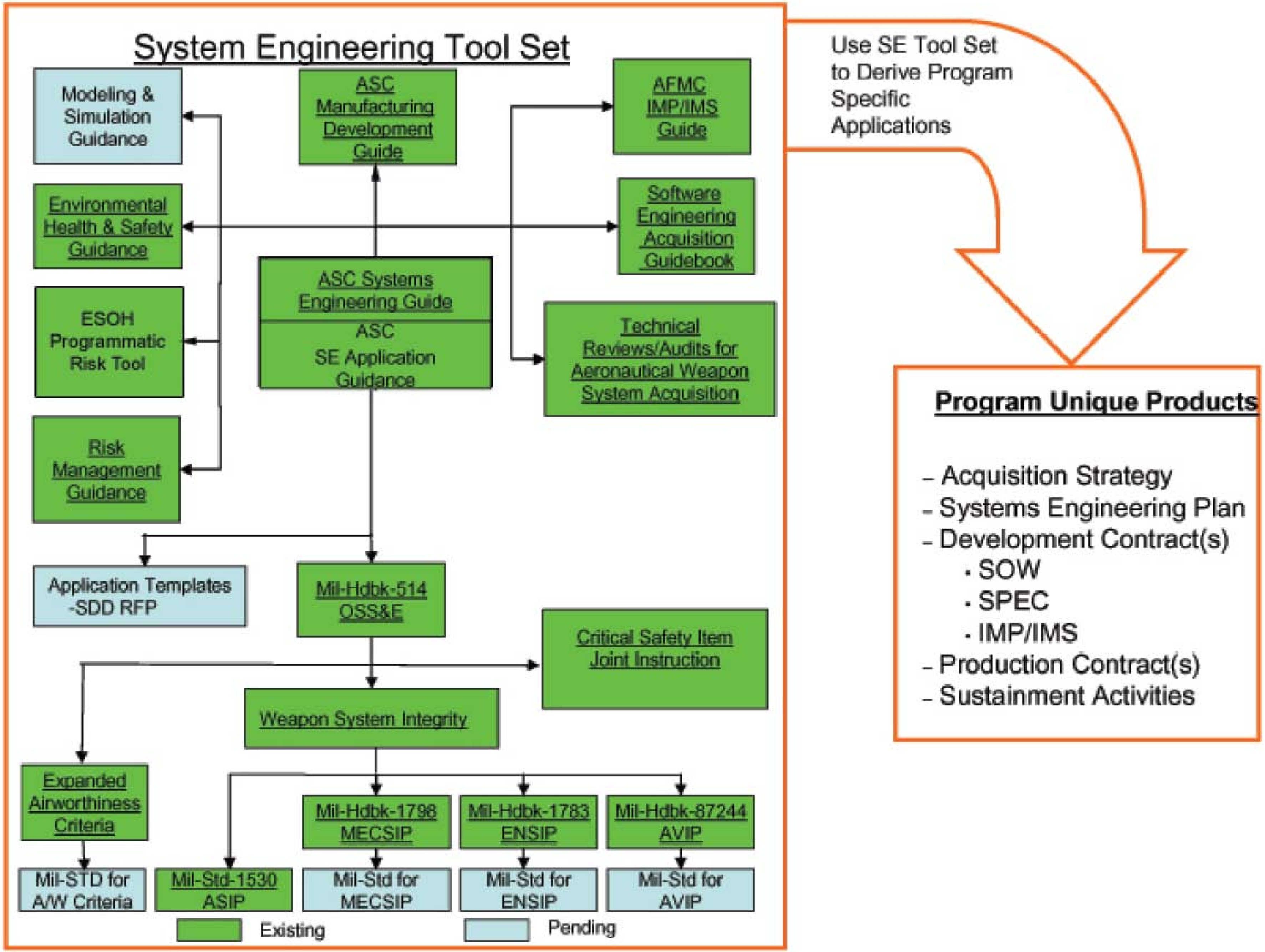
Humpty Dumpty sat on a wall,
Humpty Dumpty had a great fall.
All the king's horses,
And all the king's men,
Couldn't put Humpty together again.

Institutionalizing OSS&E Through Regulatory Products



EN Technical Processes




System Engineering Tool Set
Modeling & Simulation Guidance
ASC Manufacturing Development Guide
AFMC IMP/IMS Guide
Environmental Health & Safety Guidance
Software Engineering Acquisition Guidebook
ASC Systems Engineering Guide
ASC SE Application Guidance
ESOH Programmatic Risk Tool
Technical Reviews/Audits for Aeronautical Weapon System Acquisition
Risk Management Guidance
Application Templates -SDD RFP
Mil-Hdbk-514 OSS&E
Critical Safety Item Joint Instruction
Weapon System Integrity
Expanded Airworthiness Criteria
Mil-Hdbk-1798 MECSIP
Mil-Hdbk-1783 ENSIP
Mil-Hdbk-87244 AVIP
Mil-STD for A/W Criteria
Mil-Std-1530 ASIP
Mil-Std for MECSIP
Mil-Std for ENSIP
Mil-Std for AVIP
Existing
Pending
Use SE Tool Set to Derive Program Specific Applications
Program Unique Products
– Acquisition Strategy
– Systems Engineering Plan
– Development Contract(s)
• SOW
• SPEC
• IMP/IMS
– Production Contract(s)
– Sustainment Activities

Excerpts from: Pre-Milestone A and Early-Phase Systems Engineering

A Retrospective Review and Benefits for Future Air Force Systems Acquisition

"Two critical factors in the success or failure of programs that fall in the latter category are the need for high-quality systems engineering and the related issue of the need for a high-quality systems engineering workforce."

"On a more technical level, the NRO, in cooperation with its industry team members, has reinstituted a minimum essential set of specifications and standards on such diverse topics as systems engineering (SE) and the qualification of key components."

"But in one respect the complexity of most large systems today seems to be much greater, and that is in the complexity of the missions that the systems are asked to serve and in the number and diversity of users, supporters, and administrators of the systems. Indeed, it is often the increased complexity of external interfaces, more than internal system design complexity, that is the cause of extended development times and costs."

Space & Missile Center (SMC) ..took the first concrete steps… circa 2003!

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE SYSTEMS CENTER (AFSPC)
LOS ANGELES AIR FORCE BASE CALIFORNIA

JAN 14 2003

MEMORANDUM FOR SMC-ALL

FROM: SMC/CC

SUBJECT: Policy Letter on Specification and Standards Usage at SMC

1. Background: A key element of the Systems Engineering Revitalization effort is the use of specifications and standards as part of the technical baseline of the SMC acquisition process. Prior to acquisition reform, use of military specifications and standards in Request For Proposals (RFP), contracts and program management practices were one of the primary methods/approaches used to define technical requirements, manage contractor performance, and incorporate significant lessons learned. One key element of acquisition reform was to eliminate the government from contractually dictating prescriptive "how-to" instructions or processes used by contractors. For a decade we have limited and reduced our use of specifications and standards in RFPs, proposal evaluations, contractor performance assessments, and on contracts as compliance documents. The unintentional result was that technical baselines and processes were compromised. With the turnover, consolidations, and retirement of many industry and government personnel, we have hampered our ability to pass on lessons learned from generation to generation.

2. This directive outlines the framework for the use of specifications and standards as an integral element of SMC acquisition, contracting, and program management. There is no intent to return to the pre-acquisition reform approach of using an excessive number of specifications and standards and prescribing detailed processes. A list of high-priority critical specifications and standards is being reviewed and established for appropriate use in the acquisition process. This list will include two categories: (1) those that contribute to mission success (areas that caused failures, caused significant launch delays, shortened mission life, reduced performance, caused excessive rework, or generated important lessons learned) and (2) those needed for effective program implementation (insight into program performance or status, risk reduction, evaluations and analysis, and critical process definitions). The specifications and standards selected for the technical baseline will be reviewed in light of current acquisition practices, Operational Safety Suitability and Effectiveness policies, and new technical knowledge. They will be updated, revised, and tailored as appropriate for use at SMC. Sources of specifications and standards may include government, industry, previous SMC Commander's Policies, and specifications and standards from AIAA, ISO, or other professional societies.

Specs & Standards

Initiative

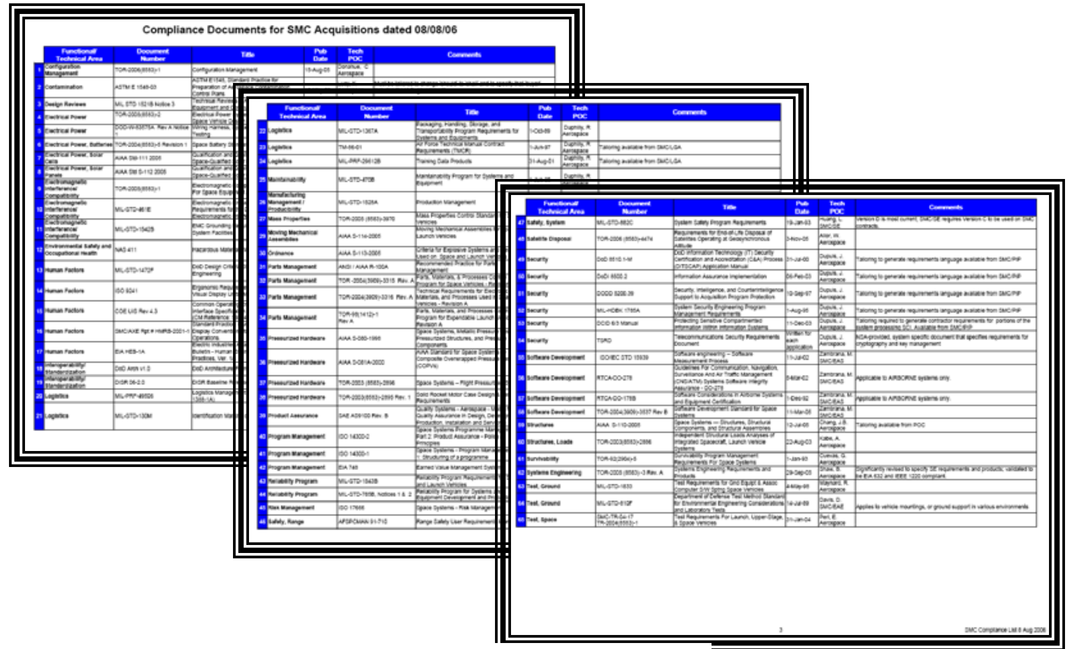
THE AEROSPACE CORPORATION

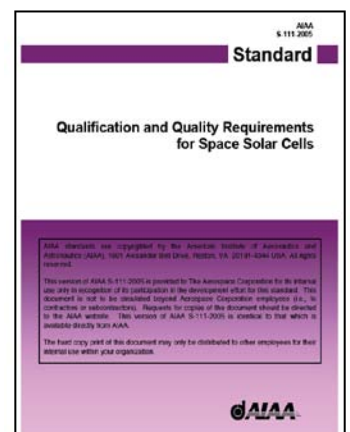
Specs & Standards Initiative

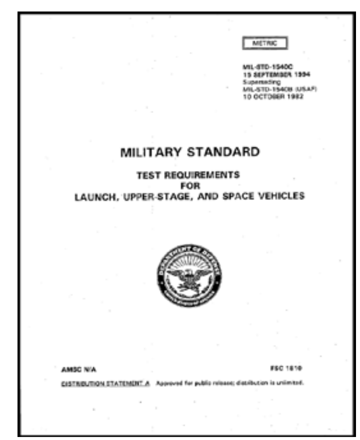
- **Apply specs & standards as element of acquisition practices and toolset**
  - **Define technical practices and expectations by government**
    - **Define the "what" – and not the "how to"**
- **Establish "Select" list of space systems standards**
  - **Establish baseline set of common specs and standards**
  - **Include military and industry (e.g., AIAA, ISO) standards**
- **Establish Organizational Policy**
- **Specify critical standards in RFP**
  - **Compliance Documents**
  - **Baseline contractually**

SMC S&S List

- **Revised SMC S&S List published 8/9/2006**
  - **65 essential documents**
    - **Entire SMC System Portfolio**
  - **Military, International, and Industry Standards, and Aerospace TORs**
  - **Updated standards to reflect current best practices**
  - **Additional updates to current document versions**







Standards Technical/Functional Areas

- Program Management
- Systems Engineering
- Risk Management
- Configuration Management
- Design Reviews
- Product Assurance
- Electrical Power
- Electrical Power, Batteries
- Electrical Power, Solar
- EMI / EMC
- Environmental Engineering
- Human Factors
- Interoperability
- Logistics
- Parts Management/Engr
- Ordnance
- Pressure Vessels
- Reliability
- Maintainability
- Manufacturing / Producibility
- Mass Properties
- Safety
- Security
- Software Development
- Structures
- Survivability
- Moving Mechanical Assemblies (MMAs)
- Test, Ground
- Test, Space

New SMC S&S Policy

- Issued by Lt.Gen. Hamel 11 July
- Establishes specifications and standards as an integral element of SMC acquisition processes
- Applies to all new development, acquisition and sustainment contracts, including new contracts for legacy programs
- Contractual compliance through the supplier chain, as appropriate
- SMC Chief Engineer (CE) responsible for master list of compliance documents
- SPO's, with CE, generate tailored set of specs and standards and recommend to PEO for implementation
- SMC/CC/AFPEO – Space resolves issues

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS SPACE AND MISSILE SYSTEMS CENTER (AFSPC)
LOS ANGELES, CA

JUL 11 2006

MEMORANDUM FOR SMC-ALL

FROM: SMC/CC

SUBJECT: Initial Policy on Specifications and Standards Usage at SMC

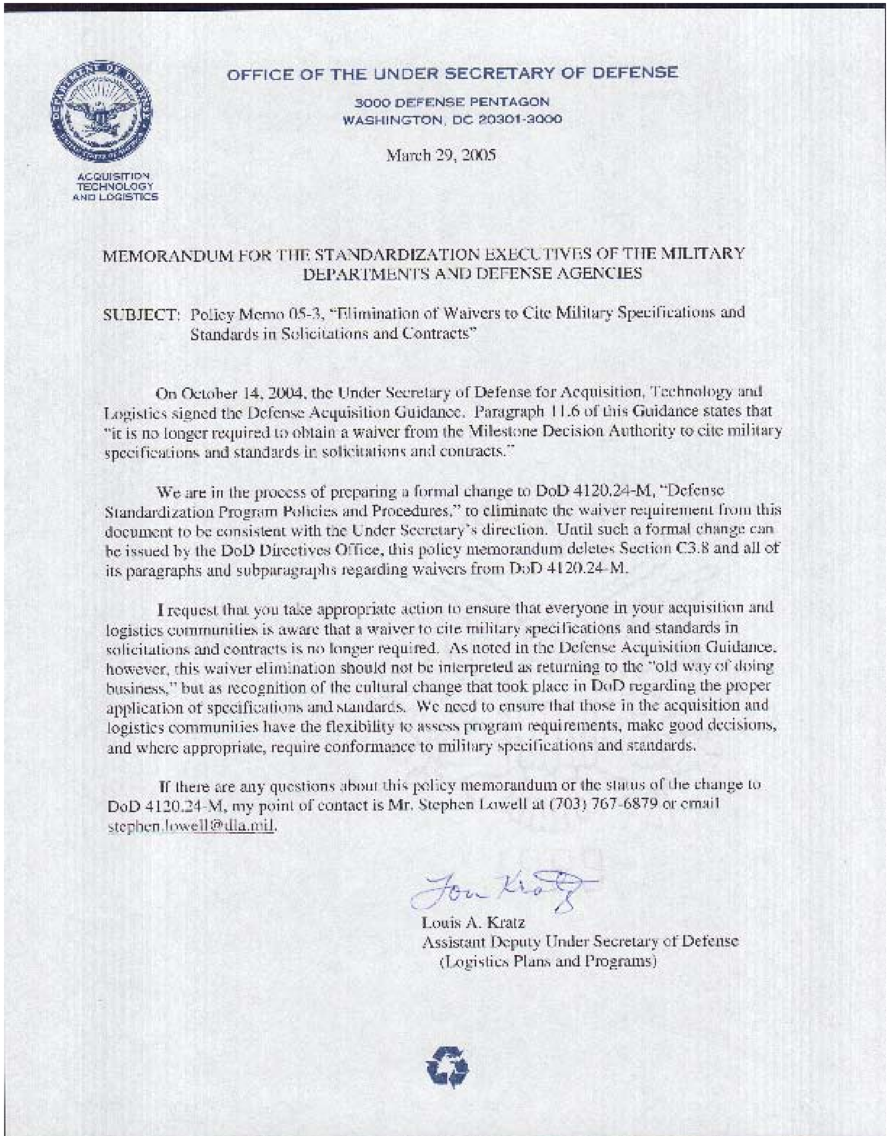
1. This policy establishes the use of specifications and standards as an integral element of SMC acquisition processes. Programs executed by SMC/AFPEO-Space shall include specifications and standards in all solicitations and shall place them on contract as compliance documents through the supplier chain, as appropriate.

2. The SMC Chief Engineer shall be responsible for defining, coordinating, maintaining, updating and reporting the master list of compliance documents. The list includes the minimum essential government, industry, professional and international specifications and standards for SMC's total portfolio of launch vehicles, space vehicles, ground systems, user equipment, missile systems, facilities and research. This policy applies to all new SMC/AFPEO-Space development, acquisition and sustainment contracts, including new contracts for legacy programs. For existing programs and contracts, the SPO's, with the SMC Chief Engineer, will assess the program, status, requirements, technical baseline and risks to generate a tailored subset of specifications and standards. This subset will be recommended to SMC/CC/AFPEO-Space for implementation. The necessary specifications and standards will be placed on contract, as part of the program's baseline and the Program Office shall enforce them. Any issues on specifications, standards or implementation that arise between SMC/EA and SPD's will be brought forward to SMC/CC/AFPEO-Space for resolution.

3. The Chief Engineer shall prepare an SMC OI to institutionalize the practice and intent of this policy.

MICHAEL A. HAMEL
Lieutenant General, USAF
Commander

Recent Actions



OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION TECHNOLOGY AND LOGISTICS

March 29, 2005

MEMORANDUM FOR THE STANDARDIZATION EXECUTIVES OF THE MILITARY DEPARTMENTS AND DEFENSE AGENCIES

SUBJECT: Policy Memo 05-3, "Elimination of Waivers to Cite Military Specifications and Standards in Solicitations and Contracts"

On October 14, 2004, the Under Secretary of Defense for Acquisition, Technology and Logistics signed the Defense Acquisition Guidance. Paragraph 11.6 of this Guidance states that "it is no longer required to obtain a waiver from the Milestone Decision Authority to cite military specifications and standards in solicitations and contracts."

We are in the process of preparing a formal change to DoD 4120.24-M, "Defense Standardization Program Policies and Procedures," to eliminate the waiver requirement from this document to be consistent with the Under Secretary's direction. Until such a formal change can be issued by the DoD Directives Office, this policy memorandum deletes Section C3.8 and all of its paragraphs and subparagraphs regarding waivers from DoD 4120.24-M.

I request that you take appropriate action to ensure that everyone in your acquisition and logistics communities is aware that a waiver to cite military specifications and standards in solicitations and contracts is no longer required. As noted in the Defense Acquisition Guidance, however, this waiver elimination should not be interpreted as returning to the "old way of doing business," but as recognition of the cultural change that took place in DoD regarding the proper application of specifications and standards. We need to ensure that those in the acquisition and logistics communities have the flexibility to assess program requirements, make good decisions, and where appropriate, require conformance to military specifications and standards.

If there are any questions about this policy memorandum or the status of the change to DoD 4120.24-M, my point of contact is Mr. Stephen Lowell at (703) 767-6879 or email stephen.lowell@dla.mil.

Lou Kratz

Louis A. Kratz
Assistant Deputy Under Secretary of Defense
(Logistics Plans and Programs)

OUSD/AT&L Policy Memo 05-3, "Elimination of Waivers to Cite Military Specifications and Standards in Solicitations and Contracts"

Translation: "You are now free to use the <u>right</u> tool for the job!"

ASC SE Road Show - 2005

- Overview - Gary Van Oss
- SE Tool Set
  - SE Toolset Foundation – Charles Gebhard
  - Modeling and Simulation – Pat Montanaro
  - Product Integrity – Bill Kinzig, Rich Stepler

--- Break ---

  - Airworthiness – Bob Fitzharris
  - Software – Mike Nicol
  - Environmental – Alex Briskin
  - Specs and Standards – Scott Kuhnen
- SE Plans – Gary Van Oss
- Wrap up / Q & A – Gary Van Oss

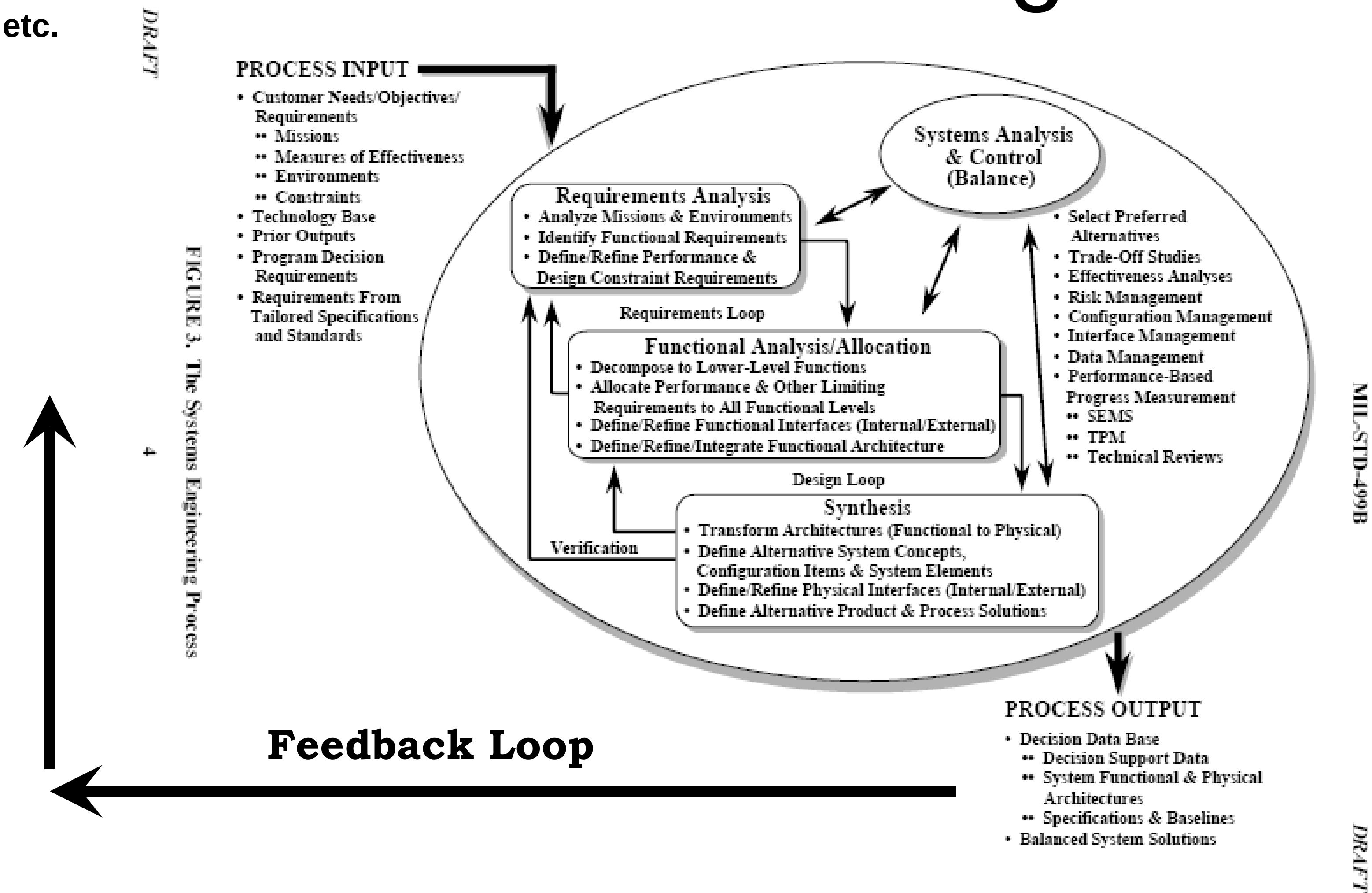
Defense Standardization Program

- ASC/EN is responsible for development and maintenance of Engineering Standards under Defense Standardization Program (DSP)
  - Mandated by Public Law 82-436; DoD 5000.1&2; DoDD 4120.24; DoD 4120.3-M; AFPD 60-1; AFI 60-101
- Wing engineering tailors and applies standards
  - Responsible for application feedback to ASC/EN
- Industry design teams also use MIL specs and standards

It's part of your day job!

Systems Engineering “Engine”

- Defense Specifications
- Defense Standards
- Qualified Products Lists
- Non-Gov’t Standards
- Int’l Standards
- etc.



My Assertion…

- Specs & Standards are not gone!
  - We are “down to” only 12,000 in the aero sector

- Spec & Standards, and all the work it takes to create them, coordinate them, update them, understand them, use them, is “foundational” to the execution of the SE process (not a “crutch!”)

- Development of, use of, translation of technical requirements is the heart of the technical portion of the SE process… ..as we revitalize SE, consider the role that specifications and standards play in the overall “business” of systems engineering.

Benefits of the DSP

- Standards are “foundational” to all that we do
  - Measuring program execution, success and/or failure
  - Moving both the State-of-the-Art and managing the Tried-and-the-True
  - Reducing risks in programs and in the SE process
  - Providing “confidence” to those who actually <u>execute</u> the SE process
  - Documenting & Communicating Lessons Learned
  - “Mentoring” the Next Generation (“Here kid, read this!”)
  - Communicating technologies and strategies across entire sectors…forming a common understanding
  - ..Shall I continue…?

AFRL Contracted Study

- AFRL RX (formerly ML) contracted an analysis of their specs & stds workload in 2008-09.
- Draft report in works…(excerpt):

"Military specifications and standards served as:

a. Procurement documents.

b. A record of experiences and lessons learned.

c. Benchmarks in system acquisition.

d. A resource for subject matter experts.

e. A tool for mentoring and transferring knowledge.

f. An aid in developing and transitioning new R & D programs and transitioning technology. "

HQ AFMC/ENS Stdzn Study

• Request of AFMC Centers for “key” specifications, standards, or handbooks which they would like to see returned to their SE Toolset?

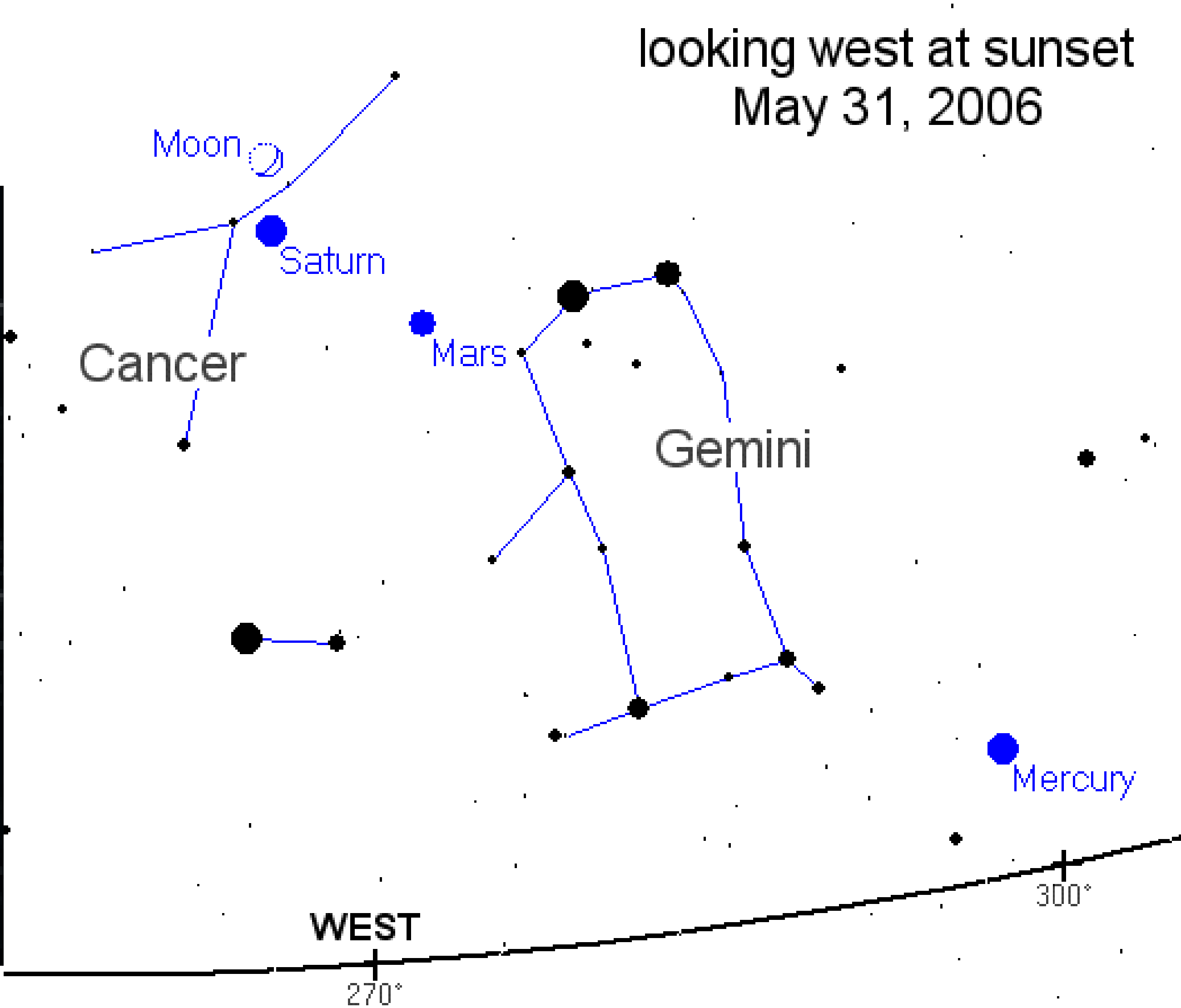
• Initial/Raw Results: 104 different documents requested for possible re-instatement.

•Approximately 25 of these were requested by multiple organizations…covering such topics as: Reliability, SE, Config Mgt, Corrosion, Software, Materials, Reviews & Audits, FMECA…many being related to what we call standard practices.

What can you expect from AF?

- **AFMC D&SWS Council** has endorsed a continued study of reinstating and using key stdzn docs.
  - Planning timeline due in June of 2010
- **SAF/AQRE** appreciates that certain “standard practices” (rather than “guides”) would be useful to restoring both common understanding and discipline back into acquisition.
- Industry involvement is critical…again this time!
- We solicit your interest & support
  - The stars may be aligning…again…

No, seriously...



Contact

Mr Robert B. Kuhnen

HQ AFMC/ENS

robert.kuhnen@wpafb.af.mil

Back Ups

Standards Live!

DoD Document Summary (Active & Inactive)

– *Specifications*	**18,834**
– *Standards*	**864**
– *Handbooks*	**406**
– *CIDs*	**4,941**
– *DIDs*	**1,019**
– *QPL’s*	**758**
– *Non Gov’t Standards*	**9,223**
– *International Standards*	**1,961**

..in all the Services/Agencies

Preparing Activity by Service (Active & Inactive)

– ***Air Force***	**2,610**
– ***Army***	**8,891**
– ***Navy***	**10,321**
– ***DLA***	**13,908**

Which Standards Matter to ASC?

Def. Stdzn documents:	Military	NGS	Total
Preparing Activity (speaks for DoD)	371	363	734
AF Custodian (speaks for AF)	6356	2742	9098
AF Review Activity (reviews for ASC)	1140	265	1405
	7867	**3370**	**11,207**

- Design Handbooks (17)
  - Shipping only 1- and 2-series documents today - on CD
- AF Characteristics Guides (6)
  - Shipping only - have only begun migration to CD
- Misc. support to other technical docs & publications
- Bottom Line: Each of the sectors (Space, Aeronautical Maritime)…all have a body of knowledge…standards.

NAVAL
POSTGRADUATE
SCHOOL

Advanced Simulation Course for Army Simulation Management Professionals

Gene Paulo
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Naval Postgraduate School
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(831)656-3452

Stephanie Few
Department of Systems Engineering
Naval Postgraduate School
smfew@nps.edu
(704)274-5178

Monterey, California
WWW.NPS.EDU

Introduction

NPS tasked by the Army Simulation Proponent Division to develop, deliver, and sustain an executive level course

Course sponsored by the Simulation Proponent Division, office of the Army Modeling & Simulation Directorate for the US Army

Course Developed & Delivered by NAVAL POSTGRADUATE SCHOOL

Army Advanced SIM Course

Course Purpose:

Two week senior leaders course for LTC/COL level FA57 and senior civilians in the Army M&S Community.

Focus:

Provide a NON-technical perspective of significant M&S issues.

Army Advanced SIM Course

Scope:

- Equip students with better M&S management skills at Direct Reporting Unit (DRU), Army Command (ACOM), and Program Executive Officer (PEO) level.
- Familiarize students with current M&S management concerns throughout the Acquisition Life Cycle, specifically the different M&S applications in use during each phase.

Army Advanced SIM Course

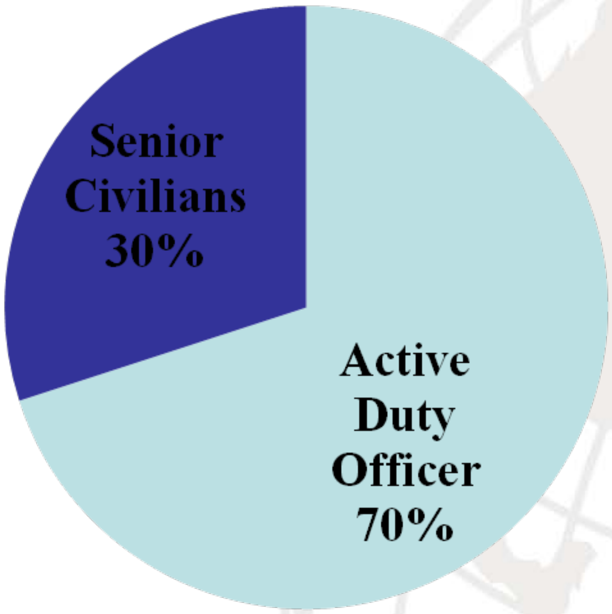
Prototype Course:

- **Objective:** Discover educational gaps, identify appropriate target audience, and determine potential for future offerings.
- **Delivered:** 11-22 May 2009
- **Location:** NPS Center for Executive Education (CEE)

Army Advanced SIM Course

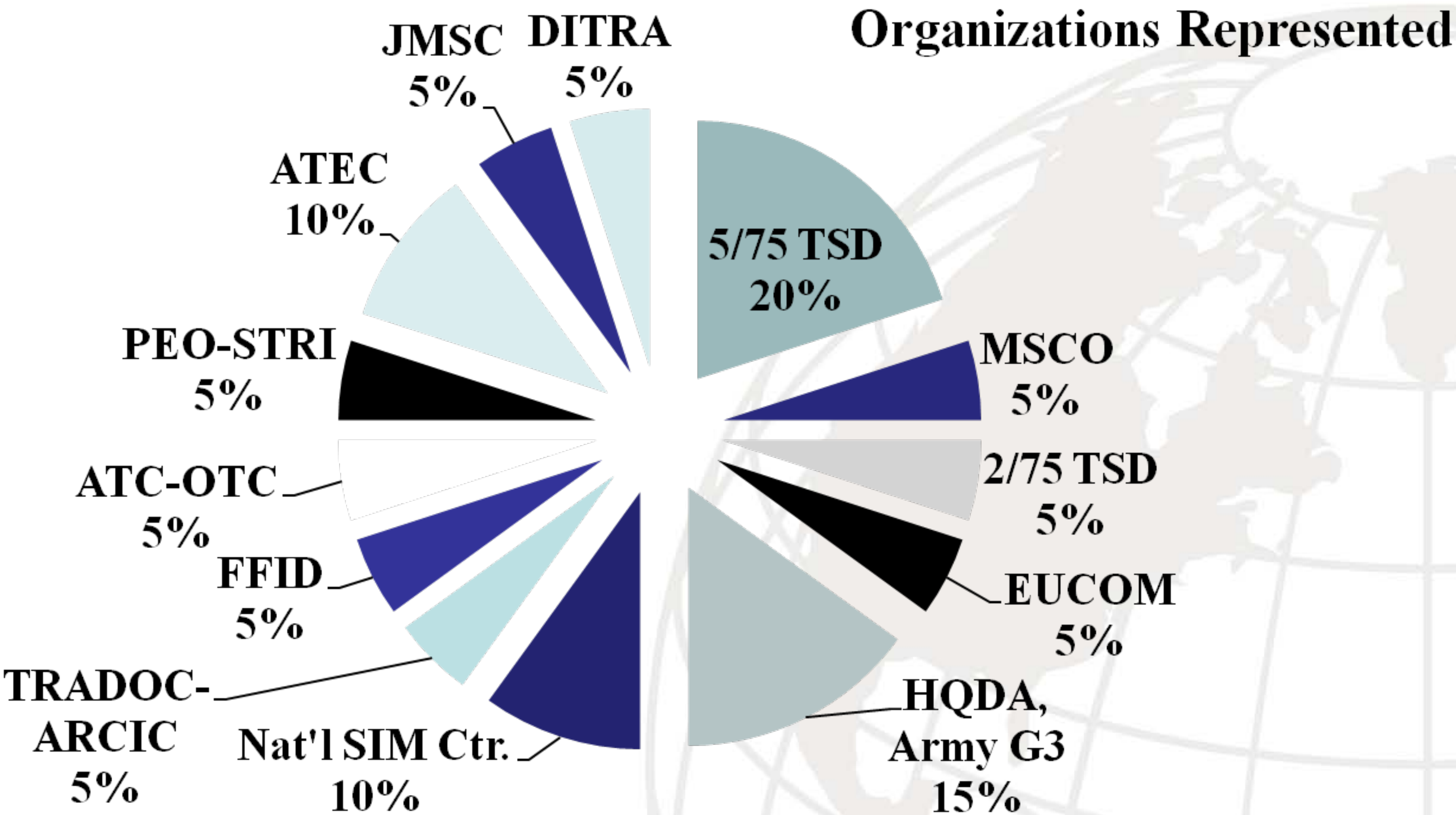
Prototype Course:

Student Body: 20 Total



NAVAL POSTGRADUATE SCHOOL

Army Advanced SIM Course



Prototype Course: NPS Department Participation

- Computer Science
- Graduate School of Business & Public Policy
- Modeling, Virtual Environments, and Simulation (MOVES)
- Operations Research & Simulation Experiments & Efficient Designs (SEED) Center
- Systems Engineering

Army Advanced SIM Course

Prototype Course: SME Participation

– NPS Thesis Students

– GSResearch LLC

Prototype Course: Breakdown

- **Module 1: Management Concerns Regarding M&S**
  - Week 1 (Lessons 1-5)
- **Module 2: Lifecycle M&S Issues**
  - Week 2 (Lessons 1-4, plus Guest Lectures)

Prototype Course: Topics

Module 1: Management Concerns Regarding M&S

- **M&S Education (Lesson 1)**
  - Role of SIM professional, development & significance of MSBOK, and *what* should an M&S curriculum contain for DoD M&S professionals
- **M&S Requirements (Lesson 2)**
  - Overview of DoD M&S, M&S Standards, LVC, M&S Requirements Generation, M&S Fidelity and Resolution, VVA, DoD Stakeholders, DoD Organizations, Governing Docs, Army M&S Domains
- **M&S in Testing (Lesson 3 & 4)**
  - T&E Overview, Why We Test, Different Testing Types (DTE, OTE, LFTE and Military Experimentation)
- **M&S in Analysis (Lesson 5)**
  - Overview of DoD Analysis Domain and Development of Analytical Simulation Study

Prototype Course: Topics

Module 2: Lifecycle M&S Issues

- **M&S Acquisition (Lesson 1 & 2)**
  - Focus of M&S in Acquisition, JCIDS and use of M&S in JCIDS, DoD Life Cycle and M&S in DoD Life Cycle, M&S Challenges in Acquisition over the DoD Life Cycle, M&S Contracting Considerations, SIM Based Acquisition (SBA)
- **M&S in Risk, Cost, and Decision Analysis (Lesson 3)**
  - M&S in Risk and Cost Analysis in Program Management, M&S support in Decision Making
- **Future Trends in Simulation (Lesson 4)**
  - M&S Convergence of Live, Virtual, and Constructive Simulation
  - Serious Games and massively Multiplayer Games, Agent Based Models, Other New M&S Trends
- **Guest Lectures (Provided expert knowledge and techniques)**
  - Concept Refinement
  - M&S Education Opportunities for DoD Communities

Prototype Course: Supplemental Materials

- Case Studies
- Lesson Pre-Reads
- Handouts
- Group Exercises
- In-Class Tool Application
- Instructor Lead Discussion

Lessons Learned…

Army Advanced SIM Course

- **Course Assessments**
  - Each student completed a daily assessment, a weekly evaluation, and overall course evaluation.
  - Each daily evaluation focused on the topic delivered that day
  - Student feedback will be incorporated into future course offerings
- **Some Changes:**
  - FA57s Only
  - Incorporate more SMEs from DoD and Industry
  - More Practical Exercises

The Way Forward…

Army Advanced SIM Course

<u>Next Course:</u>

26 April – 7 May 2010

Naval Postgraduate School -CEE

Contact us for more information…

Naval Postgraduate School –SE Department

Dr. Gene Paulo
Course Facilitator & Instructor
(831)656-3452
eppaulo@nps.edu

Ms. Stephanie Few
Research Assistant
(704)274-5178
smfew@nps.edu

Questions?

Backup Slides…

How the Army Uses M&S

	Analysis Community	Intelligence Community	Planning Community
What	Conduct Analyses on performance, effectiveness, survivability, trade offs, cost/benefit, logistical systems, personnel systems , army force structure and risk. • Combat XXI, • AWARS • CASTFOREM • Janus • Spreadsheet Modeling • CMS2 • APHAKS • JICOM • AMP • MIDAS and GAMS	Provide actionable events designed to stimulate/simulate the proper HUMINT, SIGINT, and GEOINT intelligence disciplines gathered in real world operations. • TACSIM • BSS • IEWTPT • CSP • MUSE • NWARS • QSIDS • JCATS • JLCCTC Federation	Conduct a system of systems approach to various planning tools (i.e. Force Management Model • ARFORGEN • CFAST • APIT • APEX • MIDAS • ELIST • APOD/AST • INFO-21 • JOPES and JFAST • JDLM • ADEPT
Impact	Total Army Analysis products, determining effectiveness of weapon systems, determining performance and system characteristics of equipment and system purchases, determining effectiveness of force management decisions	Training intelligence personnel for COIN operations , and OIF/OEF activities	Determining warfighting capabilities requirements, conducting research and development, and providing resources. ARFORGEN analysis and modeling.
Who	CAA, TRAC, AMSAA	Army G2, USAIC, JICTC, Intelligence soldiers in the Operational Army	HQDA, Army Command, ASCCs, DRUs, Operational Units Staffs

How the Army Uses M&S

	Experimentation Community	Acquisition Community	Testing Community
What	Exploring, testing and validating warfighting ideas and concepts to transform the way soldiers fight future battles. • JLCCTC Federation • HITL sims and simulators • Controlled field experiments • BLCSE • MATREX and 3CE • ATIN • OTC • ACRT • AWARS • One SAF • EDSIM • CMS2 • FireSIM • CAMEX	Provide virtual and constructive test beds thru which weapon, equipment and ammunition factors can be prototyped, tested and evaluated during the acquisition process. • ANSYS LS-DYNA • ProE, ANSYS • One SAF • MSC Adams • MPR3D • AJEM • MUVES • CB Sim Suite • ALOHA • PVTM • Visual Weight • MUVES • SIV • Casualty Reduction Model • BlastX	Employ M&S throughout program life cycle to support requirements definition; design and engineering; test planning, rehearsal, and conduct of an Army test. • Live/Virtual/Constructive • 4DWX • Overarching Contamination Avoidance Model • CBSNE • DSOM • JLCCTC Federation • ECSM • IMASE • COLPRO • DETES • DMS3 • EGI/CEGS • ETS • NETS
Impact	Conduct of experiments involving soldiers and leaders within the live, virtual and constructive environments for exploring concepts, capabilities requirements and solutions across DOTMLPF and the AC2DP process	Reduces testing time and costs and allows measurement of phenomenon that can not be measured using traditional methods. Provides data for procurement decisions. Allows for selection and characterization of optimal material solutions.	Evaluate the performance of tested items, systems and/or organizations, early examination of soldier interface and missions, determines system performance and safety.
Who	TRADOC, RDECOM, SMDC, USASOC, AMEDD, PEOs, Battle Labs, FORSCOM	ASAALT, RDECOM, PEOs	Army T&E, ATEC

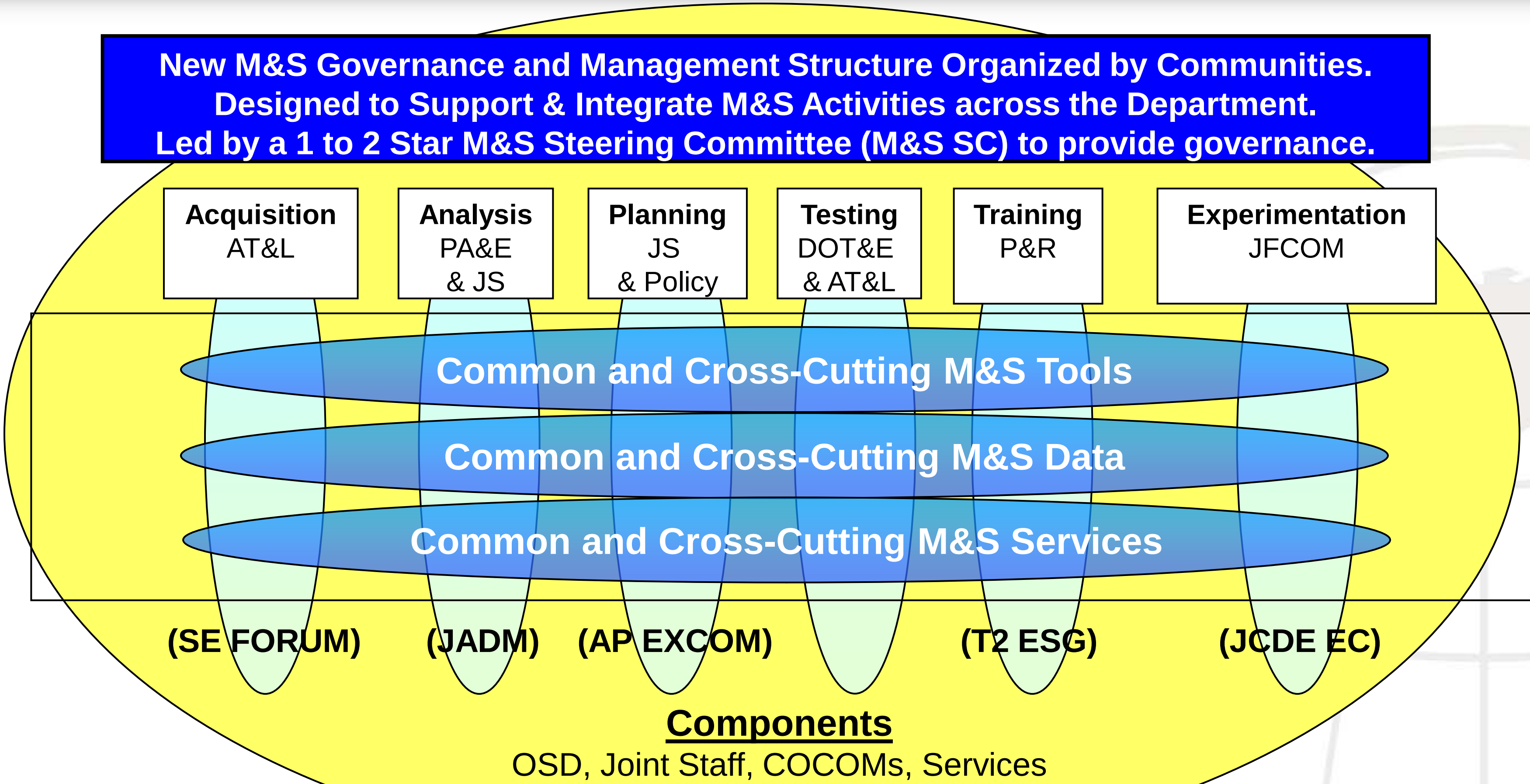
How the Army Uses M&S

	Training & Operational Community	Logistical Community

What	Delivering an integrated Live, Virtual and Constructive training environment that support the ARFORGEN model and mission rehearsal requirements.
	• JLCCTC Federation
	• Virtual Simulators
	  • CCTT
	  • AVCATT
	  • EST 2000
	• One SAF
	• JNEM
	• DCARS
	• WARSIM
	• IEWTPT
	• JNTC
	• LVC-IA
	• Gaming
		M&S develops a level of understanding of the interaction of the parts of the logistical system, and of the logistical system as a whole, seldom achievable via any other process.
		• JDLM
		• MIDAS
		• JFAST
		• ELIST
		• TARGET
		• PORTSIM
		• POPS
		• AMP
		• JCATS
		• JLCCTC Federation
		• LOGFED

Impact	Pre-deployment training exercises, mission rehearsals, trained and ready soldiers, ABCS & digital system training	Deployment timelines, training soldiers in logistical functions and units, efficiencies of logistical operations
Who	CTCs. NTC, JFCOM, BCTCs, all Army units	AMC Logistics Support Activity , SDDCTEA, soldiers in logistical units and staffs, AMC, NSC, CASCOM

Surfboard Diagram



Goal: Establish corporate M&S management to address DoD goals: Leads/guides/shepherds the $Bs in DoD M&S investments; adds value thru metrics & ROI-driven priorities; and seeks to provide transparency.

Student Daily Assessment Results

<u>Advance Simulation Course: Daily Assessment</u>
Presenter(s):
Session Title:
Date:

Please rate each item on the 1 to 5 scales, where 1 is the lowest rating and 5 is the highest.
Two different topics are delivered by different instructors on some of the course dates; therefore, some questions are repeated to access each topic separately. Topic one represents either the morning session or one full day of instruction. When applicable, topic two represents the afternoon session.

1. The objectives were clearly explained: 1 2 3 4 5
2. The content was frequently reinforced with examples:
3. The content was relevant/useful to my current or future job:
4. The value of the lecture(s):
5. The value of the class discussion:

6. The instructor was well prepared for topic **one**:
7. The instructor was well prepared for topic **two** (if applicable):
8. The concepts and ideas were clearly presented for topic **one**:
9. The concepts and ideas were clearly presented for topic **two** (if applicable):
10. The instructor focused on the applications of concepts for topic **one**:
11. The instructor focused on the applications of concepts for topic **two** (if applicable):
12. The instructor interacted effectively with participants for topic **one**:
13. The instructor interacted effectively with participants for topic **two** (if applicable):
14. Overall rating for topic **one**:
15. Overall rating for topic **two** (if applicable):
16. The value of pre-reads and handouts for topic **one** (leave blank if n/a):
17. The value of pre-reads and handouts for topic **two** (leave blank if n/a):
18. The value of the case studies for topic **one** (leave blank if n/a):
19. The value of the case studies for topic **two** (leave blank if n/a):
20. The value of small group exercises for topic **one** (leave blank if n/a):
21. The value of small group exercises for topic **two** (leave blank if n/a):
22. The overall rating for topic **one**:
23. The overall rating for topic **two** (if applicable):

<u>Comments:</u>

20 Assessments Completed Per Day

Totaled the # of ratings (1-5) per assessment, added all assessment ratings together per day for an overall idea of the day's topic likes, dislikes, and delivery.

Each rating (1-5) total was divided by # of questions completed per day (some questions did not apply) to reach the percentages.

Comment Space provided to list 3 Likes and 3 Dislikes of the day.

1 –Lowest, 5 –Highest

NPS & SME Recognition

Curtis Blais: NPS CS & MOVES

Jeff Cuskey: NPS GSBPP

Chris Darken: NPS CS & MOVES

John Dillard: NPS GSBPP

Karl Gunzelman: GSResearch LLC

Tom Hoivik: NPS OR

Mathias Kolsch: NPS CS & MOVES

Tom Lucas: NPS OR & SEED Center

Dave Matthews: NPS GSBPP

Don McGregor: NPS CS & MOVES

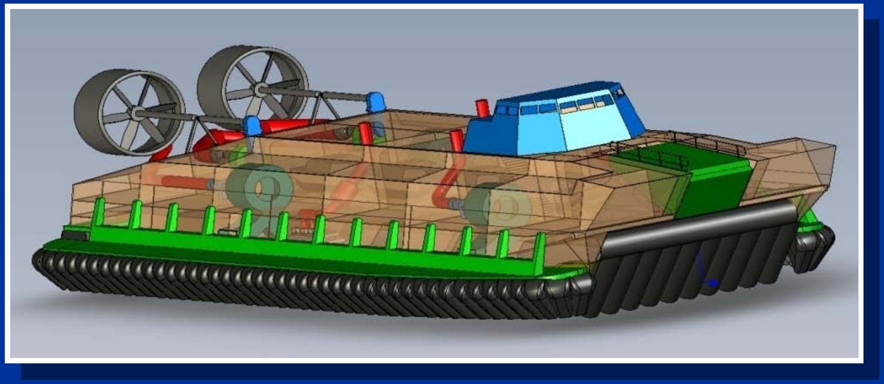
David Olwell: NPS SE

Gene Paulo: NPS SE

Mark Rhoades: NPS SE

Susan Sanchez: NPS OR & SEED Center

Naval Postgraduate School
Advanced Seabase Enabler Project: A Systems Engineering Case Study



Lance Flitter
Naval Surface Warfare Center
Carderock, MD

Gene Paulo
Associate Professor
Department of Systems Engineering
Naval Postgraduate School

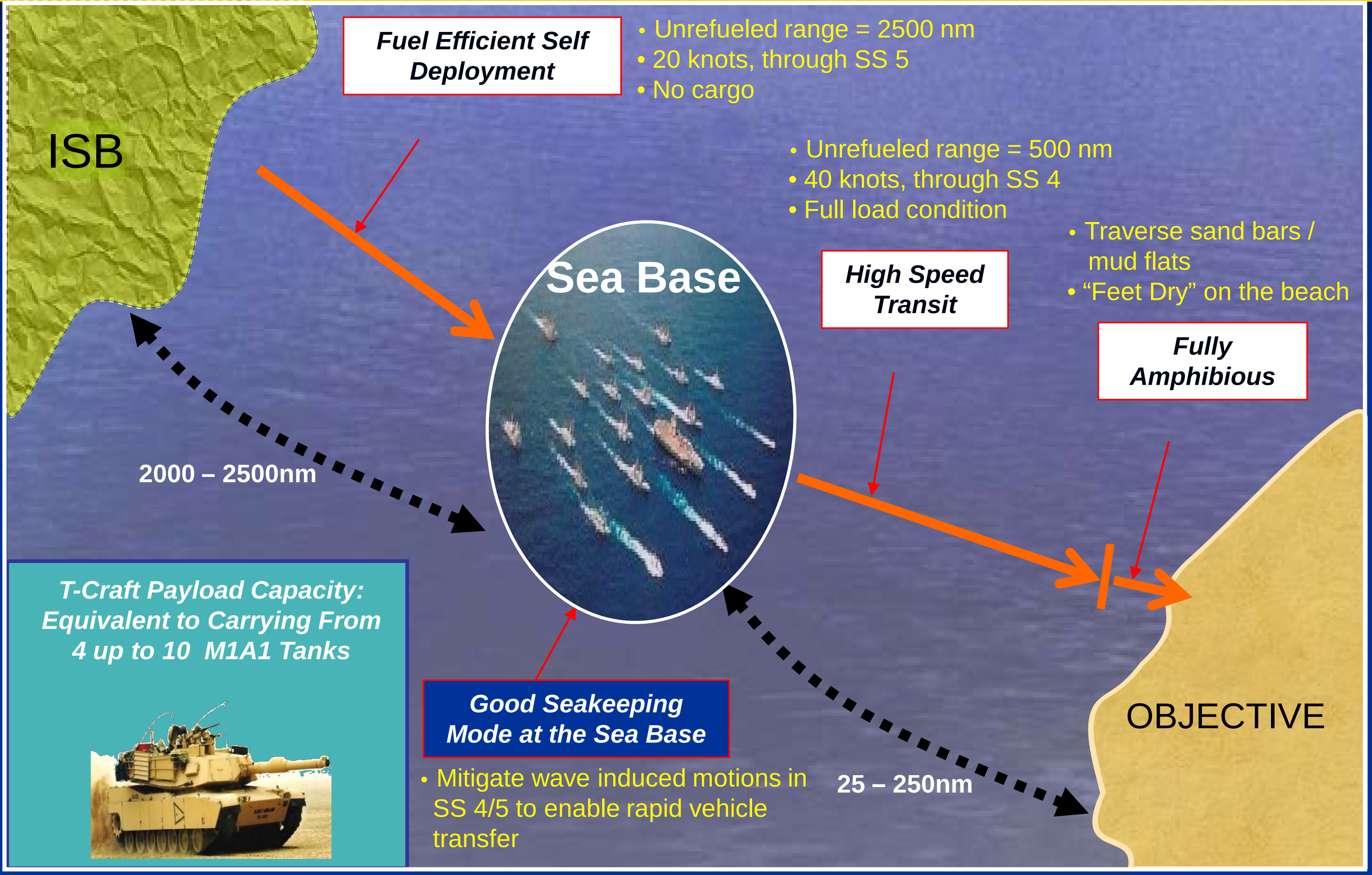
October 29, 2009

Paper **8880**

Project Overview

- This project describes a NPS capstone project as part of obtaining an MS in Systems Engineering.
- The project examined transporting cargo from a sea base to the desired destination and make recommendations regarding the best approaches for meeting those objectives. Key research goals were:
  - Determine required capabilities and functions for an ASE
  - Develop appropriate operational concept (OPCON)
  - Examine various ASE concepts, to include the Transformable Craft (T-Craft)
    - ✓ Conceptual platform under the design of the Office of Naval Research (ONR)
    - ✓ ONR sponsoring multi-year effort through NPS to assist in T-Craft system design and architecturing.

T-Craft Concept



ASE Project Stakeholders

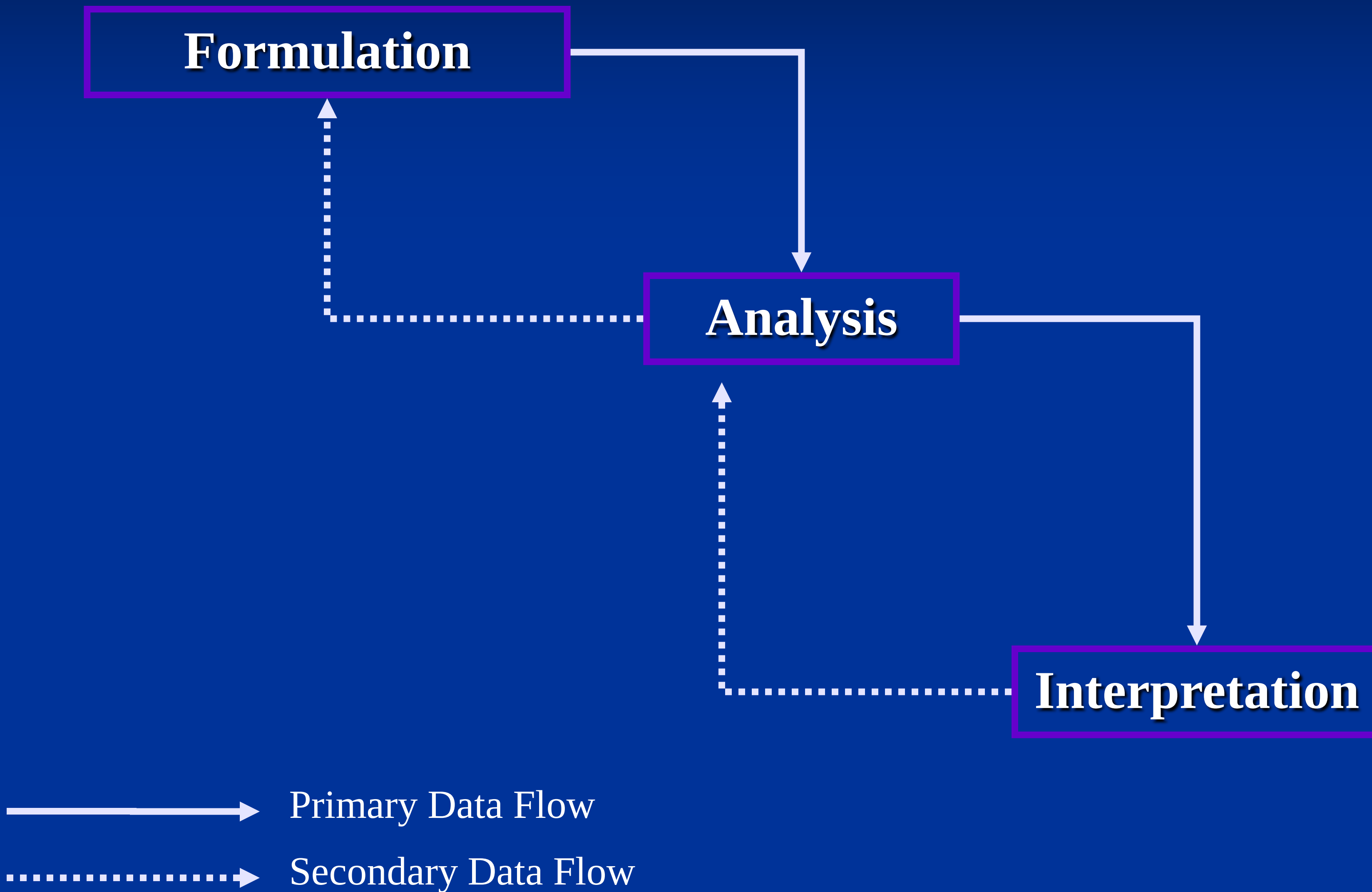
Major Stakeholders:

- Operational Commands
  - Navy
  - USMC
  - Army
  - SOCOM
  - JFCOM
  - TRANSCOM

Secondary Stakeholders:

- **NAVSEA**
- **Marine Corps Combat Development Command (MCCDC)**
- NAVSUP
- Marine Corps Logistics Command
- ONR
- TACOM
- Combined Arms Support Command (CASCOM)
- Military Sea Lift Command
- PDM Army Watercraft Systems (AWS)
- NATO
- Coast Guard

Systems Engineering Development Process

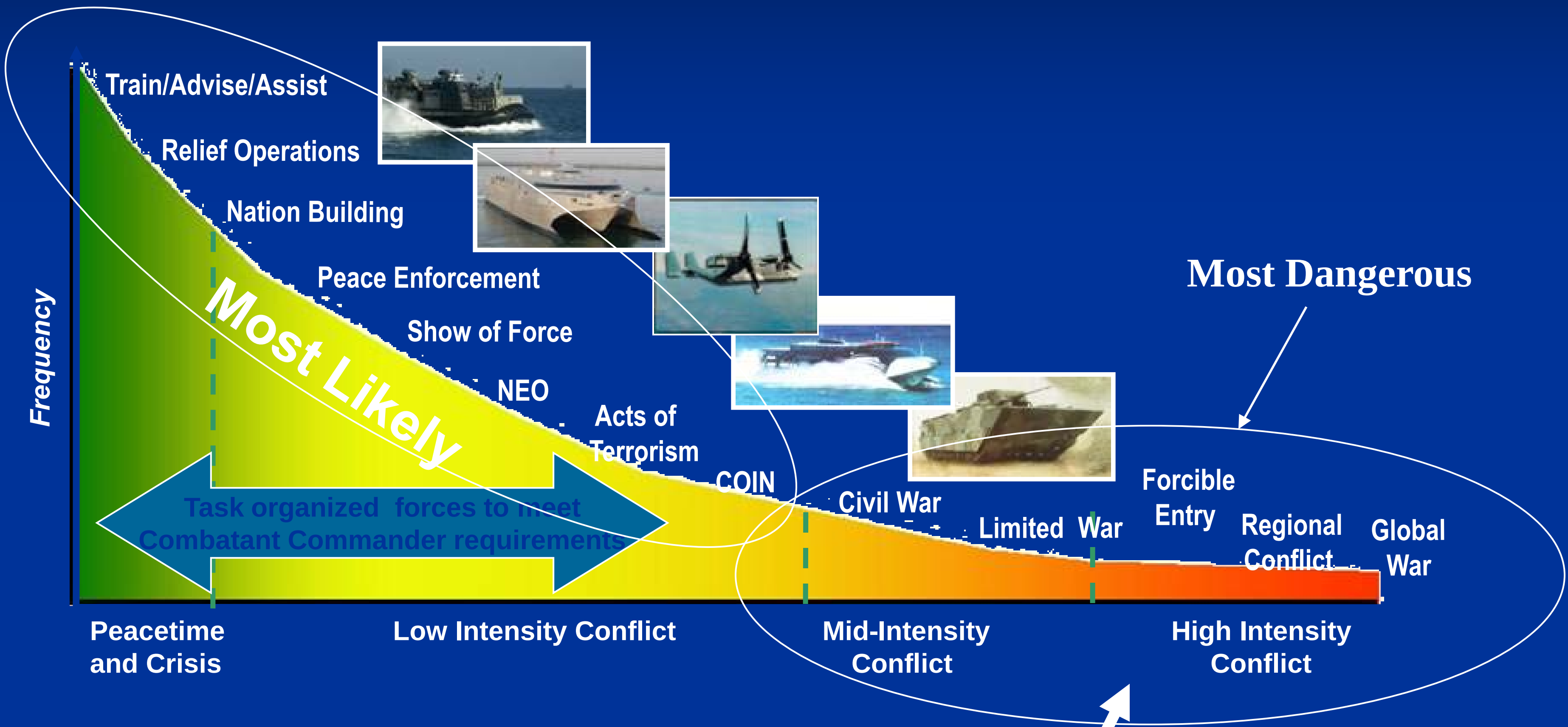


Final Problem Statement

"A capability is needed to fully enable the potential of the sea base. For a sea base to be truly beneficial a capability must exist that supports efficiently transporting needed materiel from the sea base to the desired debarkation point. The capability must support peace-time, non-combat operations' and war-time, combat operations' logistics and support needs. The solution must be cost effective and capable of operating under all environmental conditions, including sea states, under which necessary military operations are expected to take place and must support a transport rate sufficient to ensure materiel is delivered within operational time requirements."

Seabasing

Analysis of the Full Range of Military Requirements



Rigorous performance requirements
Major warfighter concern

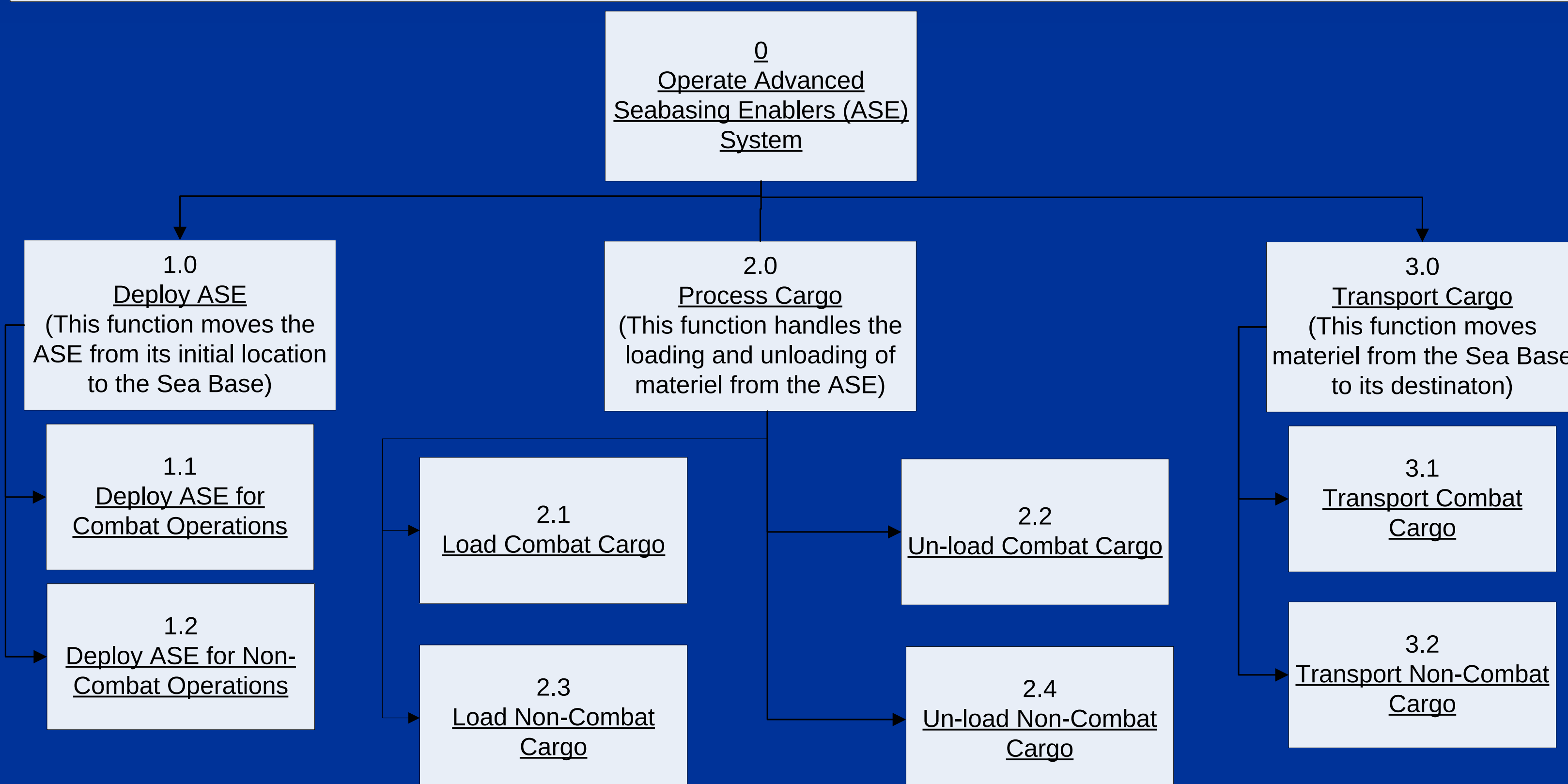
Missions

	High Threat Environment	Low Threat Environment
No Infrastructure	**Major Combat Operation** ▪ Heavy Equipment ▪ Time is essential ▪ Forcible Entry Possible	**Natural Disaster Relief** ▪ Cargo: food, medicine, personnel
Infrastructure Assumed	**Police Enforcement Operation** ▪ Light Combat Equipment ▪ May be time sensitive ▪ AT/FP type threat, not major combat	**Humanitarian Aid** ▪ Cargo: food, medicine, personnel

ASE Functional Decomposition

REVISED PROBLEM STATEMENT

For a sea base to be truly beneficial a capability must exist that supports efficiently transporting needed materiel from the sea base to the desired debarkation point. The capability must support peace-time, non-combat operations' and war-time, combat operations' logistics and support needs. The solution must be cost effective and capable of operating under all environmental conditions, including sea states, under which necessary military operations are expected to take place and must support a transport rate sufficient to ensure materiel is delivered within operational time requirements.



ASE Objectives Hierarchy
Non-Functional Requirements

- ASE Non-Functional Requirements
  - Maximize Availability
  - Maximize Maintainability
  - Maximize Transportability Options
  - Maximize Standardization & Interoperability
  - Maximize Proudicibility
  - Maximize Reliability
  - Minimize Manning
  - Maximize Environmental Performance
  - Maximize Survivalbility
    - **MAXIMIZE SURVIVABILITY**
      - Built in Wash-Down Capability
        N (threshold)
        Y (objective)
      - Signature Reduction
        Not Required (threshold)
        Reduced (objective)
  - Maximize Safety

Alternatives

- Researched several possible alternative solutions
  - LCAC (Landing Craft Air Cushion)
  - SSC (Ship to Shore Connector)
  - LSV (Logistics Support Vessel)
  - LCU (Landing Craft, Utility)
  - T-Craft (Transformable Craft)
  - JHSV (Joint High Speed Vessel)
  - Heavy Airlift
- All options already conceived. Information gathered from existing projects / programs.

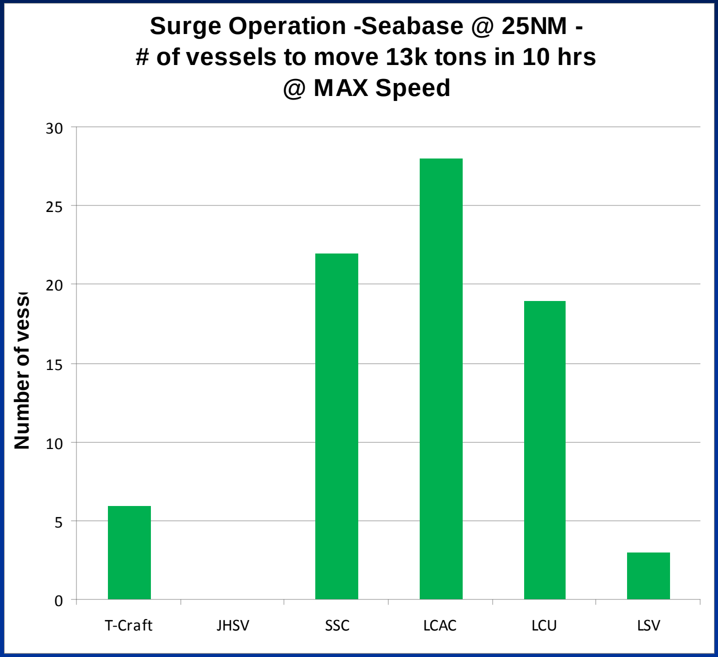
Systems Analysis

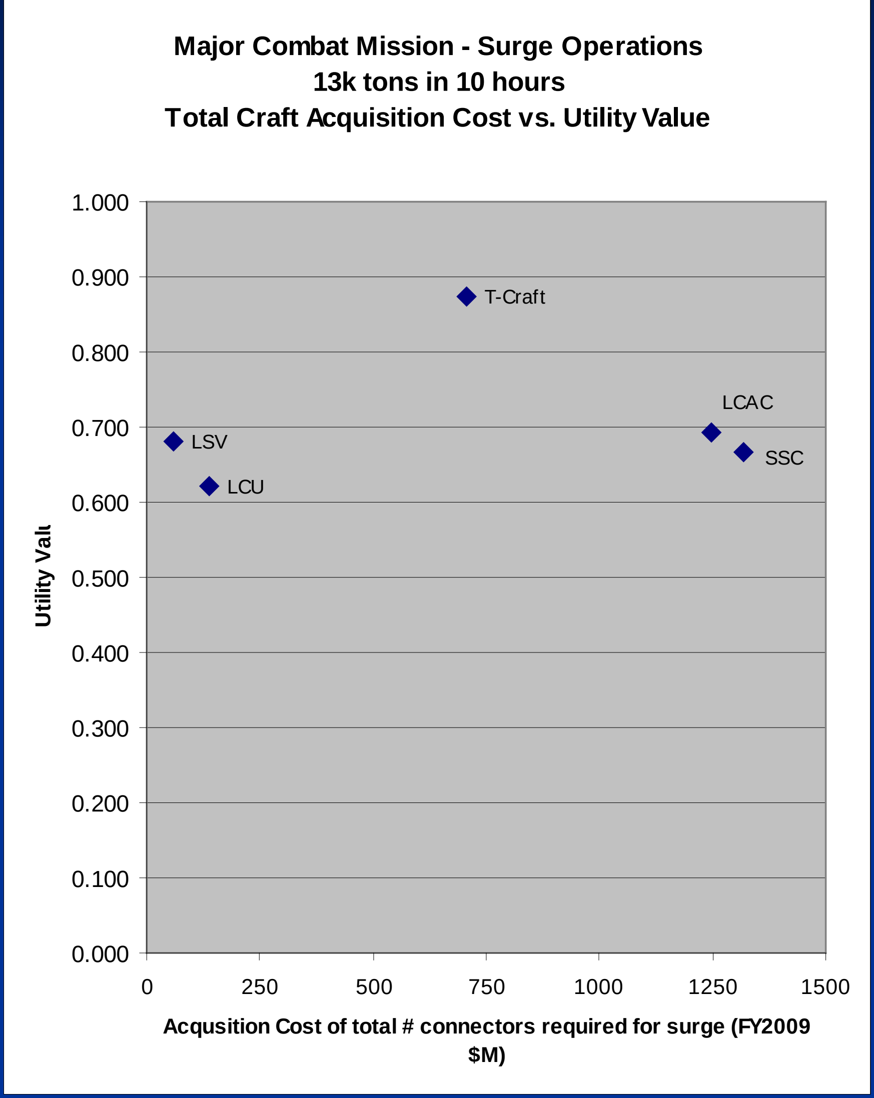
- Both static and dynamic systems analysis:
  - Using cargo capacity, speed, range of various alternatives, team members conducted comparison for both MCO and Humanitarian
  - Simulation analysis examined:
    - ✓ Extent of capability to complete the Load Cargo function, using Mean time required to assemble cargo/forces and load assembled cargo/forces.
    - ✓ Extent of capability to complete the Transport Cargo function, using mean time required to transport cargo/forces ashore.

Overall Results

- T-Craft has highest overall performance score by a large margin for combat mission
- JHSV has highest score for humanitarian mission followed by LSV and T-Craft

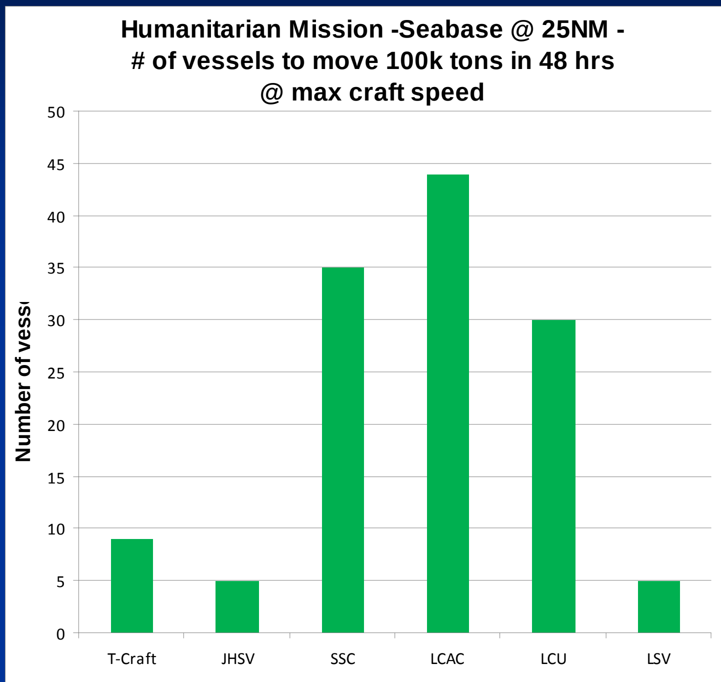
Cost vs Performance – Major Combat Operations

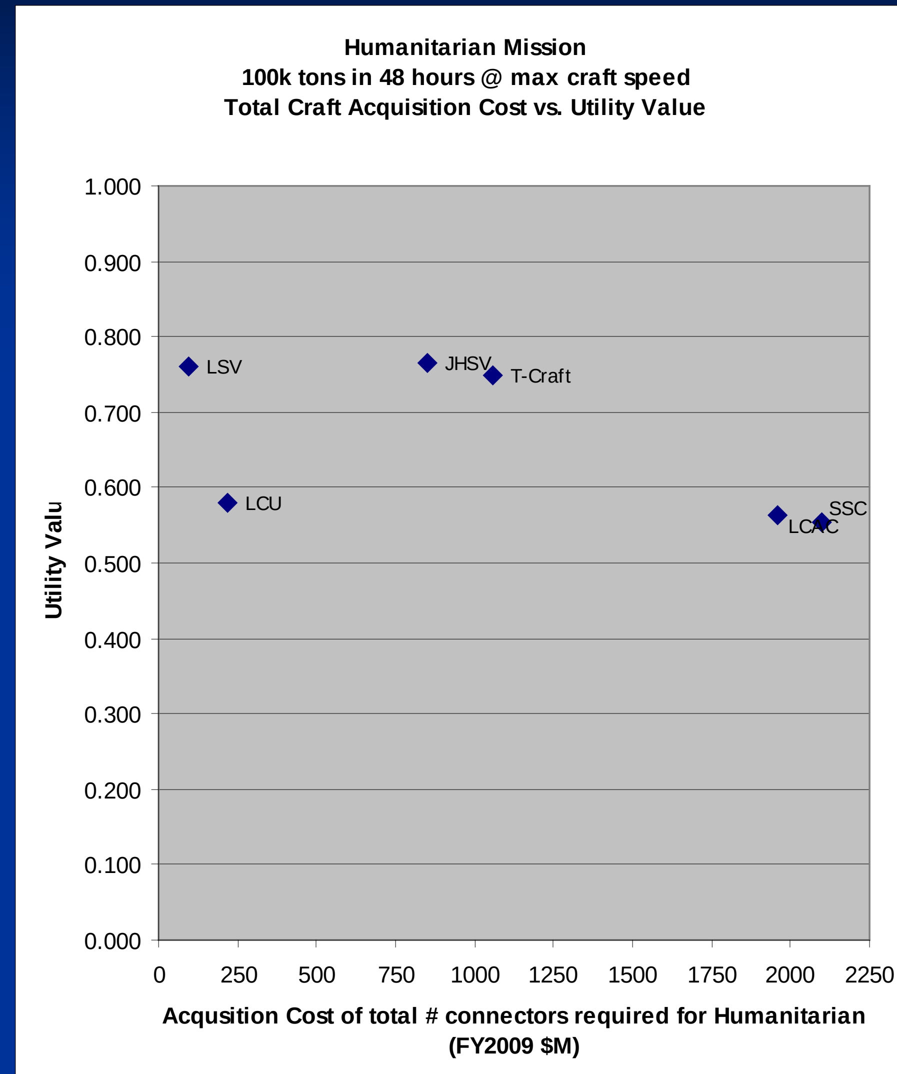




- T-Craft offers the highest utility with a moderate cost
- LSV and LCU provide moderate utility at comparatively low cost
- SSC and LCAC costs are the highest with the lower utility value due to their relatively small cargo capacity

Cost vs Performance – Humanitarian Mission





- JHSV offers the highest utility with a moderate comparative cost
- LCU and LSV again have the lowest cost with LSV having the lowest overall cost with a fairly high utility
- SSC and LCACs are obviously poor choices with high cost and low utility

FY 2010 (and Beyond) Proposed Research

- Conduct thorough systems analysis of T-Craft and Sea Base Enablers
- Examine more specific proposed T-Craft capabilities and their operational impact
- Examine other operational concepts and scenarios appropriate for T-Craft system.
- Develop a virtual representation of T-Craft for use in analysis and possibly training

Focus for FY 2010

In depth, formal evaluation of T-Craft performance, based on the systems engineering framework and operational concept developed as part of FY09 effort.

- This includes the evaluation of alternatives and decision analysis using simulation and experimental design.
- Researchers from Simulation and Efficient Experimental Design (SEED) Center at NPS support this effort
- Actively recruiting an NPS Operations Research student to address this topic for their thesis.

Focus for FY 2010

- Examine and determine the requirements for the broad simulation analysis efforts addressing T-Craft performance in a variety of operational concepts.
- Examine and determine the appropriateness of several simulation tools to meet these requirements regarding the evaluation of T-Craft performance in a variety of operational concepts.

Focus for FY 2010 (and beyond)

Create a prototypical virtual environment (VE) that can be used by designers of the T-CRAFT to inspect prospective designs.

- For example, inside the virtual environment, the designers will be able to simulate various operations in the craft to ensure that the design can support these operations.
- Additionally, the VE will be integrated into a Java-based discrete-event simulation package known as SimKit. This integration will provide a means to conduct very powerful simulation analysis in a virtual environment. At least one thorough test case of this integrated simulation will be developed and demonstrated.

Focus for FY 2010 (and beyond)

- Conduct a thorough life cycle cost analysis of the T-Craft. I have an OR student who is very interested in this as his thesis topic.
- Propose and develop a “fleet” architecture, examining different combinations of cargo platforms, to include T-Craft, that can best address transportation gaps identified by Army and USMC in specific detailed scenarios. This effort will build on our previous systems architectural development, which considered individual cargo platforms in competition with each other (LCAC, JHSV, T-Craft, etc). This portion of the project is being conducted as a graduate thesis by an NPS student in the Master of Science in Systems Engineering curriculum.

Contact Information

Questions?

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National Defense Industrial Association

Promoting National Security Since 1919

12th Annual Systems Engineering Conference

"Achieving Acquisition Excellence via Effective Systems Engineering."

San Diego, CA

October 29th, 2009

"Tactical Wheeled Vehicle Integrated Diagnostics – The Past, Potential, Politics, and Path Forward"

Larry Osentoski, President & CEO

DRIVE Developments, Inc.
7314 Nineteen Mile Road
Sterling Heights, MI 48314

DRIVE Developments, Inc.

Corporate Overview

DRIVE Developments, Inc. is a high quality engineering solution provider. Our experience is strongly rooted in vehicular diagnostics and prognostics. This is evidenced in our **DIME (Diagnostic Information Management Environment)** product line which combines over 50 years of staff experience with hardware and software development within test facilities, **remote diagnostics and fleet management**.

The breadth of our capabilities also extend into other areas of vehicular engineering to include scientific test cell development, internet applications and plant monitoring systems.

We truly believe in the philosophy of "Lead, Follow or Get Out of the Way"

DIME

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Business Highlights

- Michigan Small Business incorporated in July 2007
- Focused on Military and Commercial vehicle work
- Featured on The Economic Report with Greg Gumbel in Fall 08'
- Selected as one of "Michigan's 50 Businesses To Watch for 2009"
- Selected as Prime on $500M / 5 year TARDEC OMNIBUS

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"Tactical Wheeled Vehicle Integrated Diagnostics – The Past, Potential, Politics, and Path Forward"

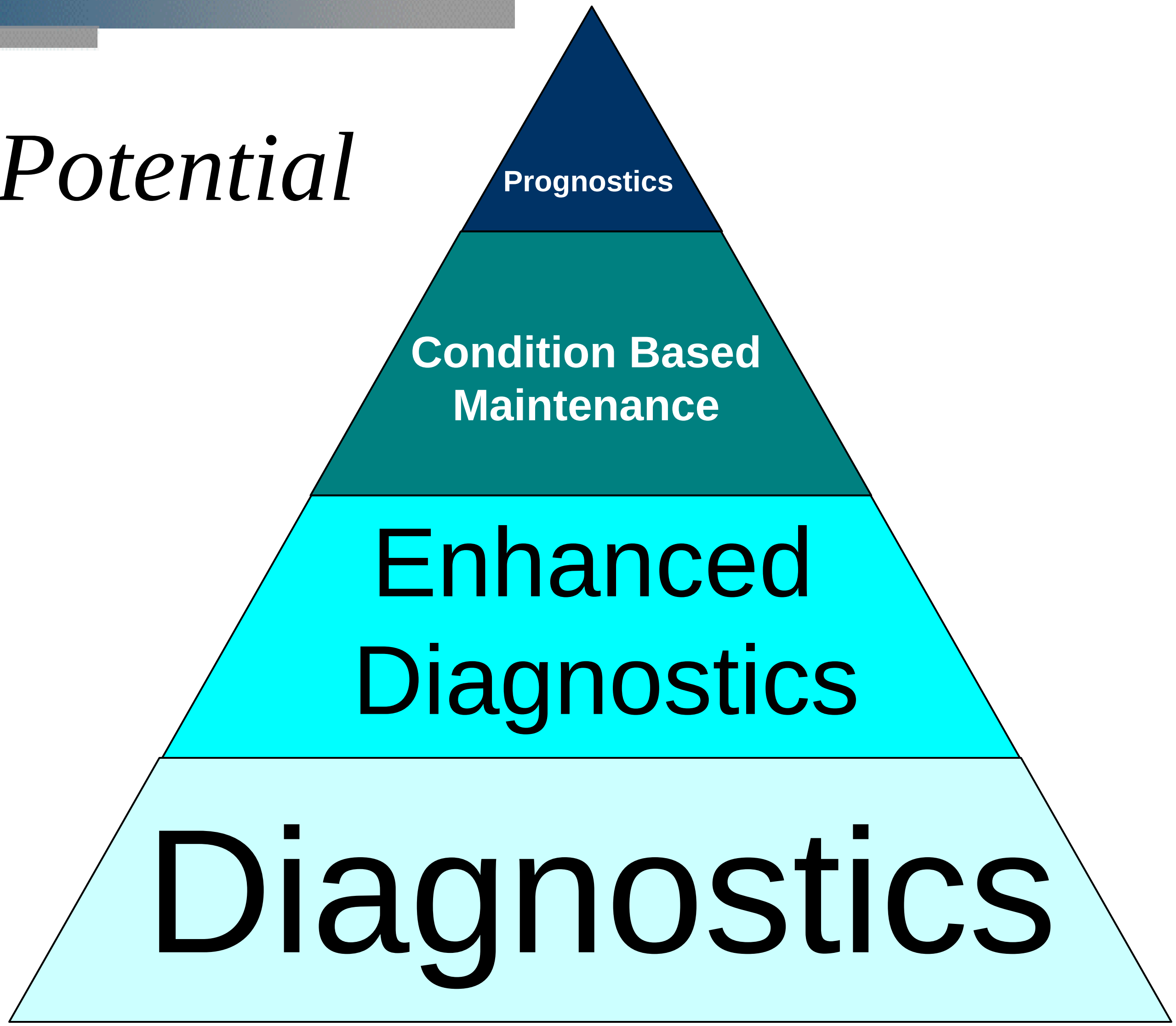
Overview

- **PAST** – Research to CRM
  - Commercial, Government, & Military
- **POTENTIAL –** *Do we really need Prognostics Day One?*
  - Overview of Benefits from Diagnostics to Prognostics
- **POLITICS** – *Do we need another stimulus package?*
  - Funding for development that inhibits deployment
- **PATH FORWARD** – A bird in the hand?
  - Success Stories

The Past

- Commercial Diagnostic Deployments
  - Automotive OEMS (Product development, CRM,Onstar)
  - Fleet Managers (dispatch, geofencing, employee monitoring)
  - Insurance Carriers (Tracking, use, and validation)
- Government Research Pilots
  - Dept of Transportation (MDOT DUAP)
  - I-95 Corridor activities (cell phone data for freeway congestion monitoring)
- Military Research
  - Congressional plus ups only, no requirement defined in most cases!
  - Diagnostics always listed as objective requirement, never a threshold requirement in vehicle OEM contracts

The Potential



The Potential (Commercial Mindset)

- Commercial market starts with diagnostics on the vehicle platform to diagnose failures as low hanging fruit for warranty and repair
- OEMs gather data to form baseline for Enhanced Diagnostics that along the way can provide CRM (Customer Relationship Management) benefit
- Seeks to develop prognostic concepts that support business objectives rather than for the challenge or academic aspects

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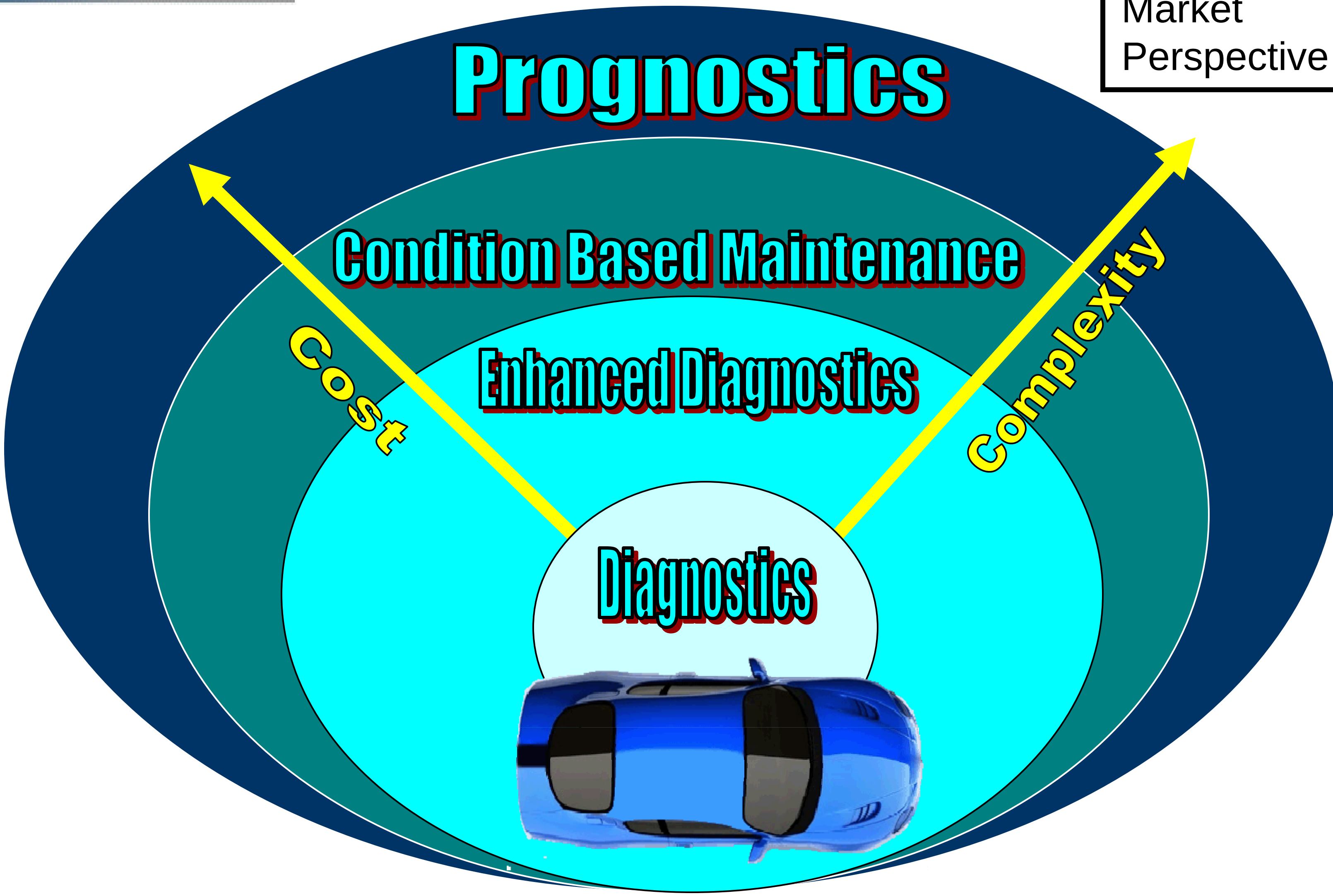
Commercial Market Perspective



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The Potential (Military Mindset)

- Seeks prognostics to predict impending component failure as first objective, heavy academic influence.
- Focuses on research to identify the perfect prognostic solution as opposed to collecting and analyzing data on existing fleets and providing immediate value.
- Disparate systems have political barriers to interoperability, not technical limitations.
- Retrofit more sensors onto vehicles to get more data.

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Military Market Perspective

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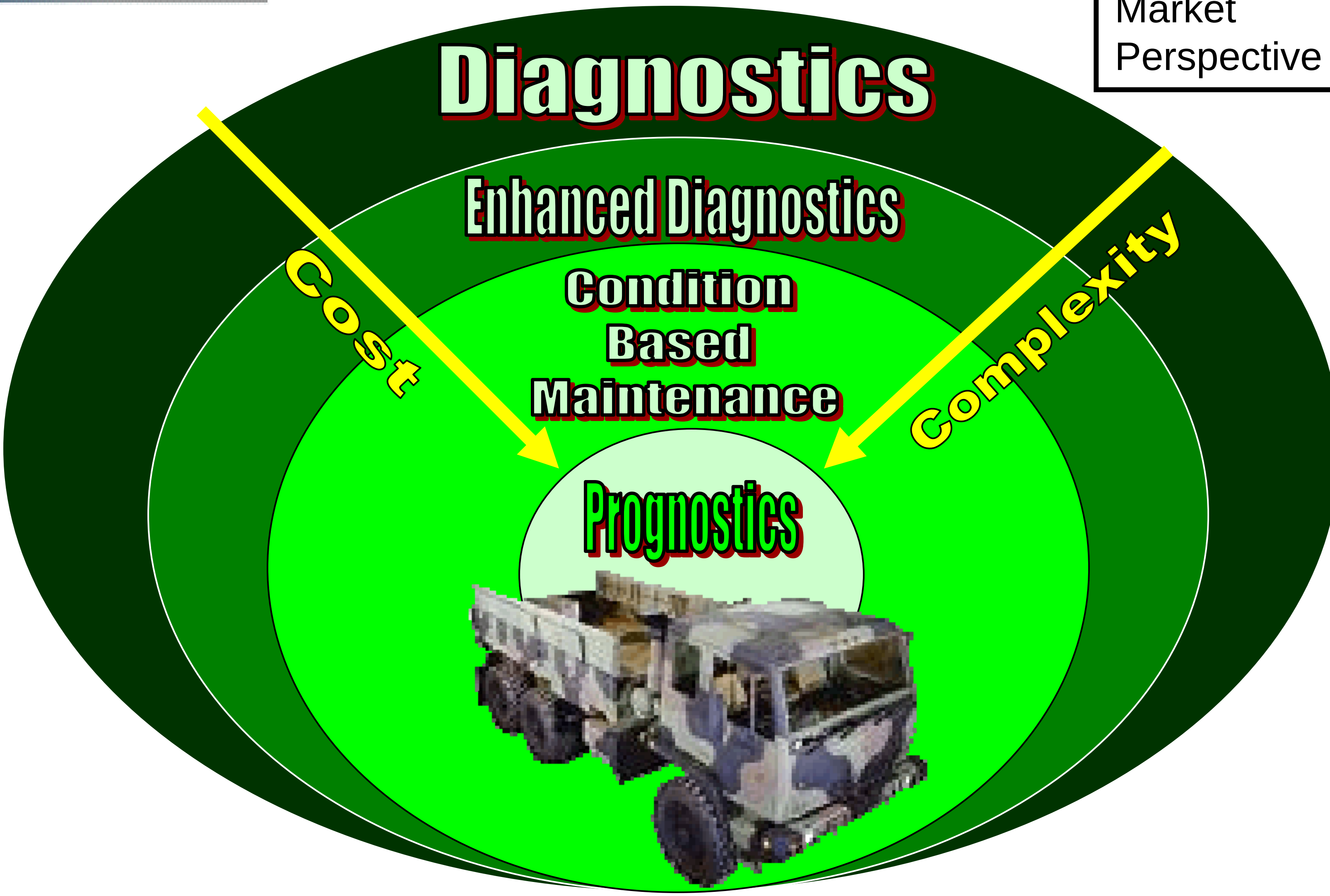

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Diagnostics

After **the failure has occurred a diagnostic scan tool can be used to identify existing issues…**

- **Assists in diagnosis of vehicle failures**
- **Enhances Maintenance History**

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Enhanced Diagnostics

Immediately After the failure has occurred a resident recording device can gather data evidence.

- **Circular Incident Buffers**
- **Situational Awareness**
- **Location History**
- **Incident Reporting**
- **Application development :**
    - **Fuel efficiency**
    - **Payload calculation**
    - **Weather Conditions**
- **Fleet Monitoring Interpolation**

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Condition Based Maintenance

Immediately After the failure the resident recording device forwards actionable data to depot

- ***Real Time****
  - **Situational Awareness**
  - **Location Tracking**
  - **Incident Reporting**
- **Application development :**
  - **Accident Detection / Reporting**
  - **Route Guidance**
  - **Integration with LOGSA**
- **Reduced MTTR due to CBM**
- **Increased MTBF due to CBM, not too early or too late based on expected component life and actual use.**

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Prognostics

Before the failure occurs the vehicle warns the entire chain of command from operator upstream.

Application development :

- **Save lives through prediction of failures**
- **Maximize Asset Utilization through use management**
- **Advanced LOGSA inventory management to reduce logistics tail be providing repair parts Just In Time**

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The Politics

- Military vs. Commercial Requirements (OnStar like technology, you can have it as a convenience. Soldiers can't get it to save their life.)
- Congressional earmarks dictate direction of diagnostics and prognostics for last decade! Mostly 6.1- 6.3 funding which is only research funding. Rewarding research instead of rewarding of implementation working with the customers in the PM Shops to fulfill operational requirements.
- Fancy program names create atmosphere of false prophecy in diagnostics space. Past failures taint the diagnostics industry. "Stenographic, multifunctional , polymer, language communications system" – Rep Jeff Flake (AZ) describing how a common ink pen would be described if included in the Defense Appropriations Bill. http://www.youtube.com/watch?v=McEz2l1EvDs&feature=channel
- PM Shops starting to fund their own diagnostics recorder because research labs have been researching diagnostics in vehicles for over a decade and have not even developed or discovered the recorder that should be used, much less the application of it. Some areas are great for research to handle, some are not. Contractors have more data than the US Army on their vehicles. Why?

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The Politics, continued…

- Not leveraging past experience of commercial markets because of need for continued research for technology that already exists in a form that can be utilized TODAY.
- Presently politics funding same work over and over (Groundhog day effect) Same projects going to same government agencies with same contractors. Only change is leadership on government side enabling this game to continue. e.g. Three year rotation cycle for 05's and 06's.
- Sexy language game sells in congressional plus up world and nowhere else. e.g. Rep Jeff Flake (AZ) quote regarding pen description.

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The Path Forward

- Success Stories
  - PM MTV : Development of Militarized version of DIME (Diagnostic Information Management Environment)
  - FUEL : 2.6 mpg savings on a Medium Tactical Vehicle TODAY! (6.6 vs. 4mpg)

U.S. ARMY

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FUEL Efficiency Research with DRIVE and Army National Guard

- Comparison of two MTVs in same usage pattern
- FUEL : 6.6mpg vs. 4mpg economy savings
  - 2003-2004 model year MTVs being driven by the PA National Guard
  - Vehicles run same routes
  - Vehicles are identical configurations
  - Vehicle A : No issues
  - Vehicle B : Diagnostic faults related to fuel efficiency

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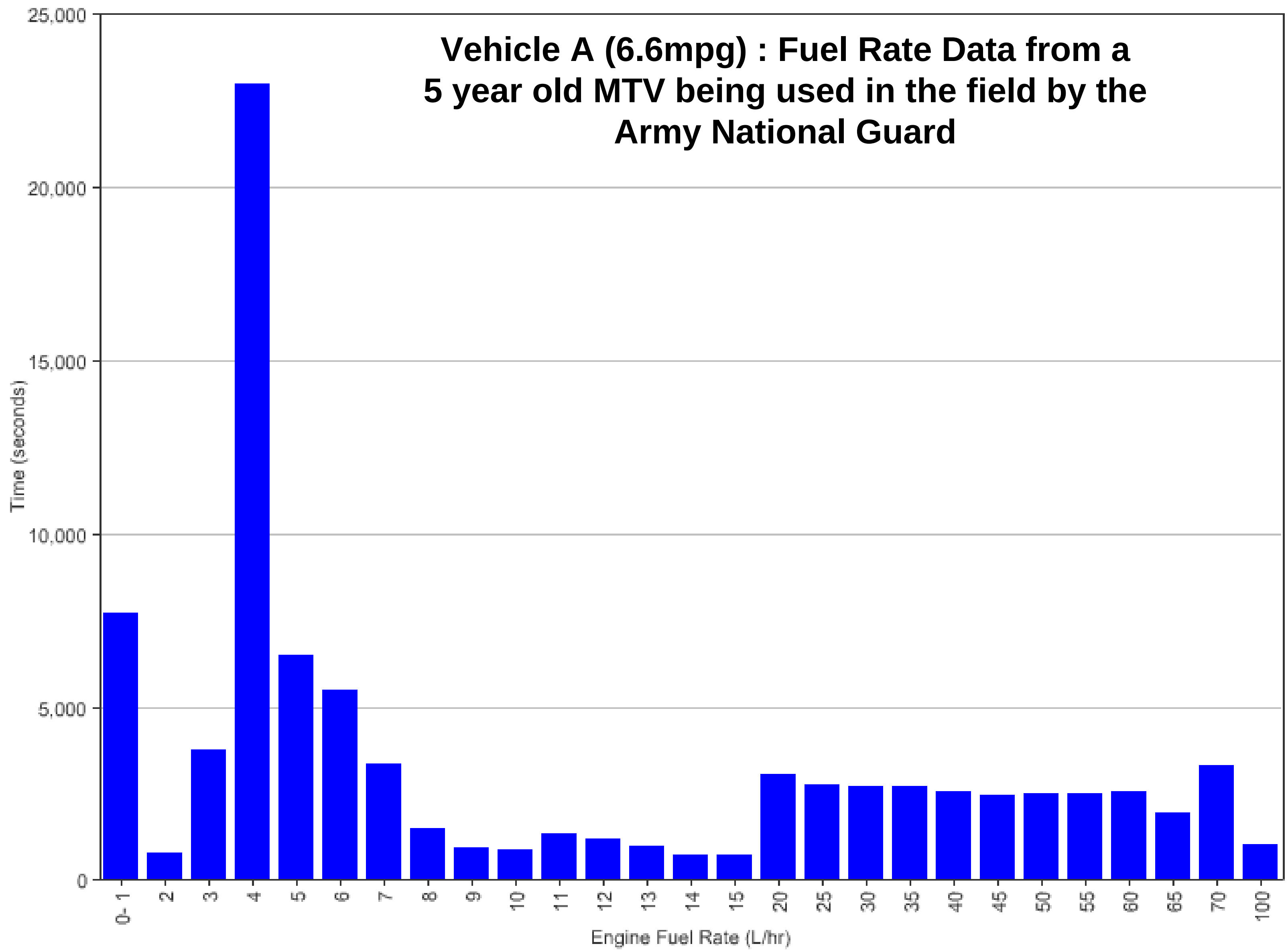

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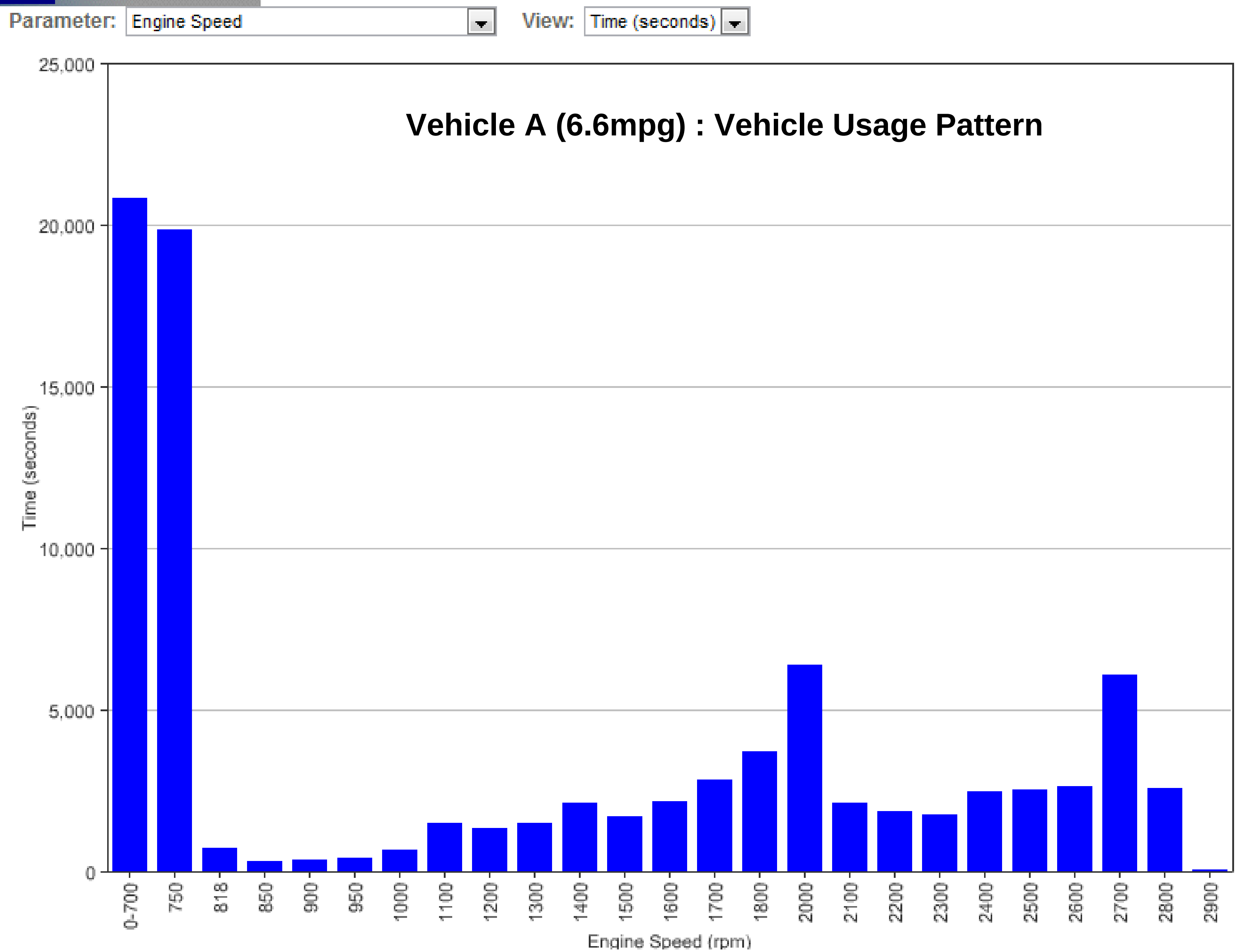

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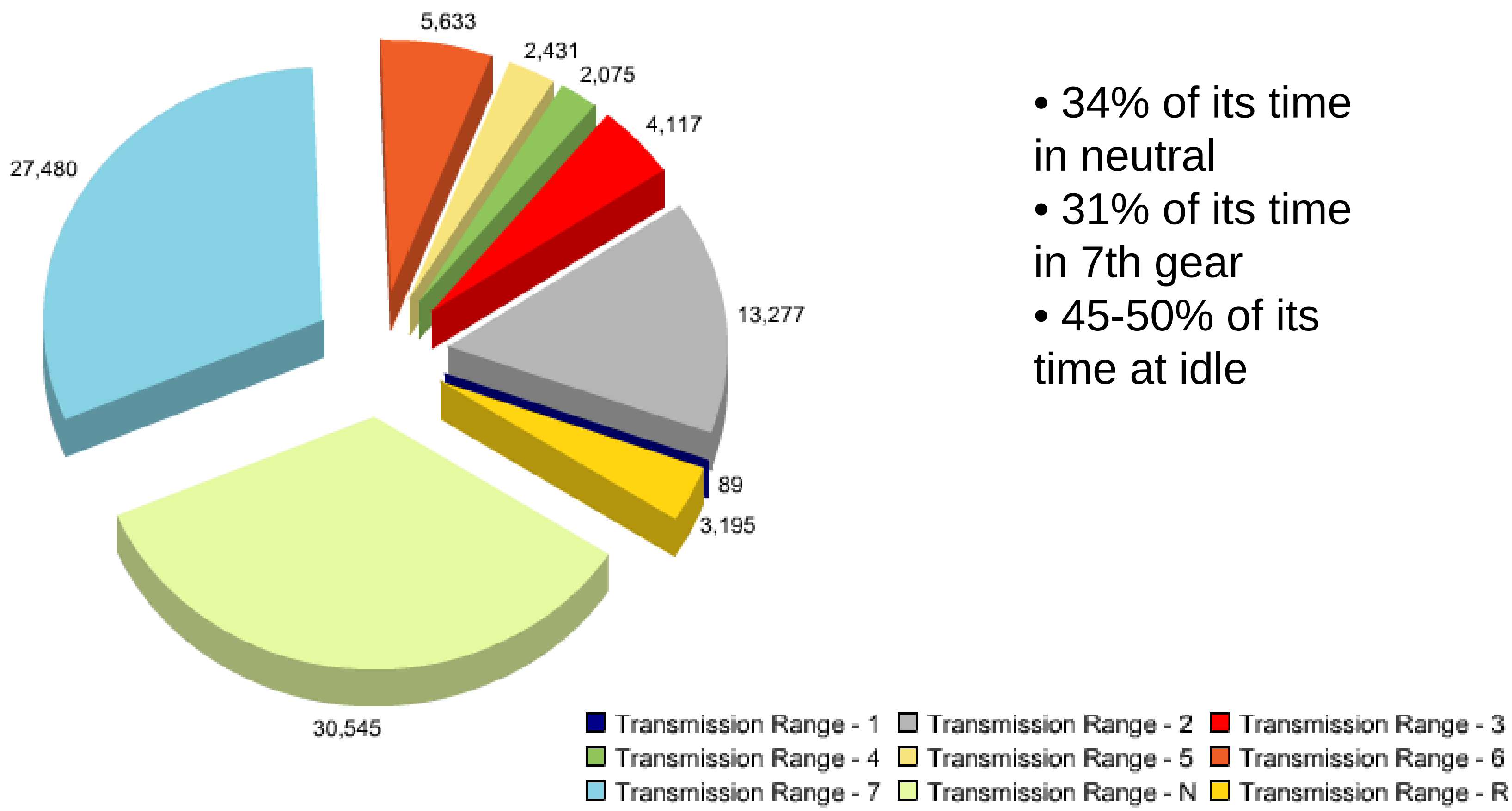
Vehicle A (6.6mpg) : Transmission state, more detailed driving usage



- 34% of its time in neutral
- 31% of its time in 7th gear
- 45-50% of its time at idle

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Vehicle A : Basic Review of Healthy Vehicle

- Vehicle fielded to this guard unit spends approximately :
  - » 34% of its time in neutral
  - » 31% of its time in 7th gear
  - » 45-50% of its time at idle
- This vehicle has numerous active fault codes some of which do not illuminate the malfunction indicator lamps.

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Vehicle Comparison

- When compared to another vehicle in the same fleet the presence of various fault conditions can lead to varying data and increased fuel consumption.

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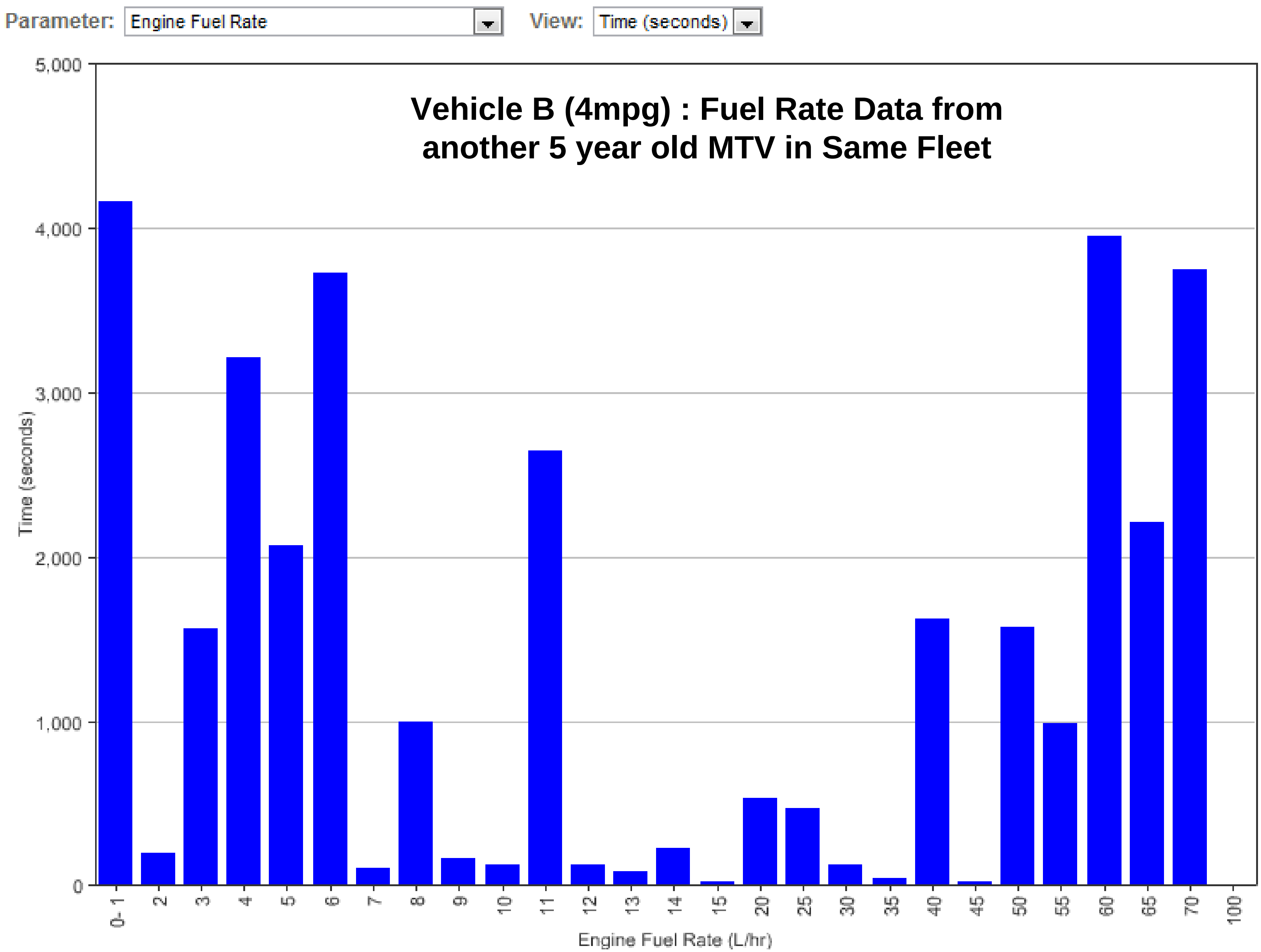

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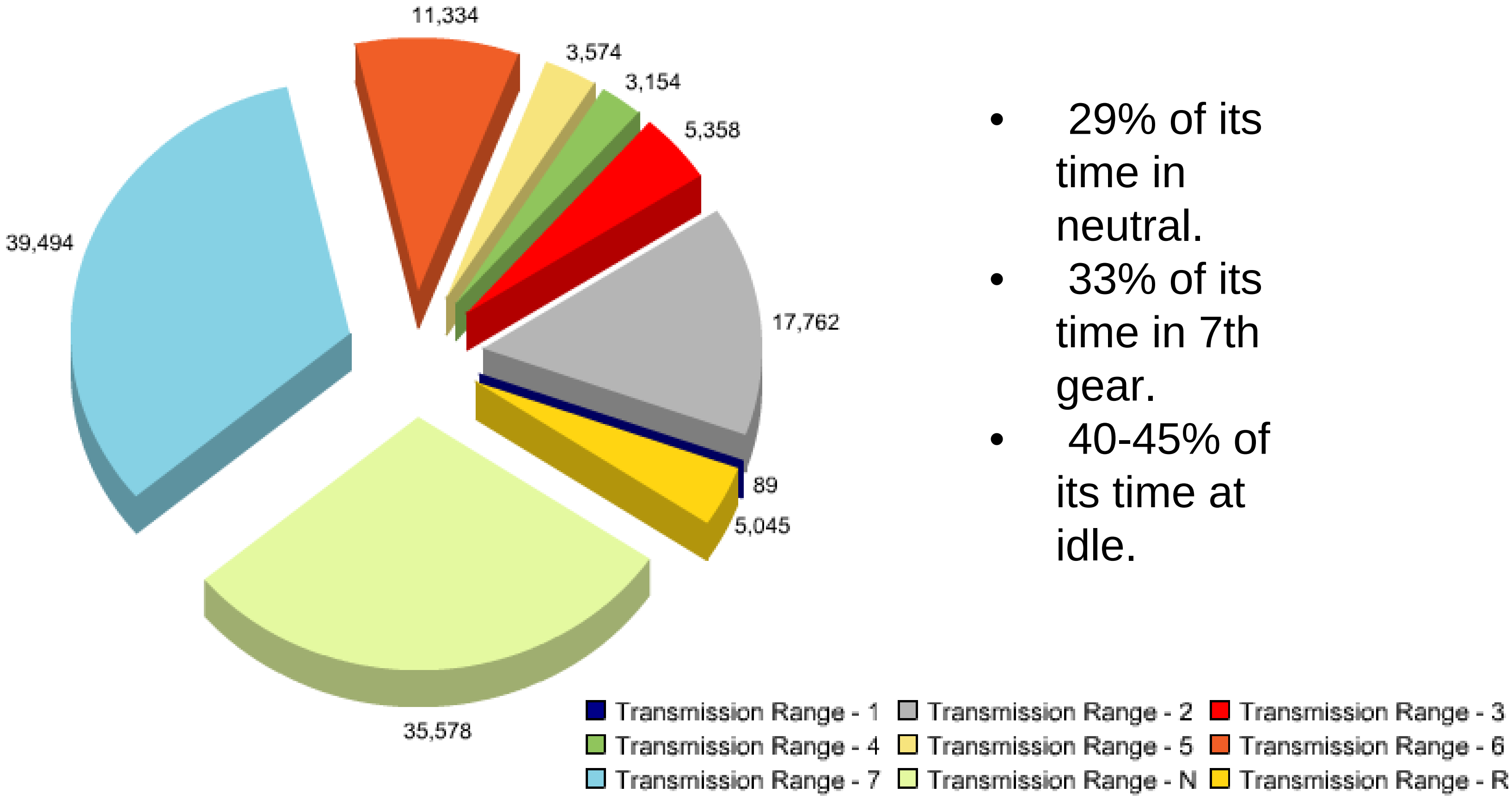
Vehicle B (4 mpg) : The Driving Pattern is Very Similar to the Healthy Vehicle A



- 29% of its time in neutral.
- 33% of its time in 7th gear.
- 40-45% of its time at idle.

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Vehicle B (4mpg) : Basic Review of the Sick Vehicle

- Vehicle fielded to this guard unit spends approximately :
  - » 29% of its time in neutral.
  - » 33% of its time in 7th gear.
  - » 40-45% of its time at idle.
  - » 3 to 5% different use than Healthy Vehicle A
- This vehicle has numerous active fault codes some of which do not illuminate the malfunction indicator lamps.
- This vehicle has network faults that limit the data collection
- This vehicle's network is reporting only about 30% of the time.
- This vehicle's fuel consumption graph is skewed and indicates that the vehicle is consuming close to 50% more fuel than it's counterparts.
- When first instrumented in early 2008 these vehicles had numerous fault codes of which the operators where not aware.
- Nearly every major system was reporting fault codes
  - – Engine, Central tire inflation system and brakes.

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Vehicle B (4mpg) : Basic Review of the Under Performing Vehicle

- Both vehicles were experiencing injection actuation pressure system faults when first instrumented.
- Most faults occurred at higher RPMs (2k +)
- Most faults occurred before the engine was completely warmed up emphasizing the need for data capture on startup
- Operators reported that they noticed some vehicles seemed to require more fuel when refueling even though the general operation was basically the same.
- After repairs at depot the sick vehicle fuel consumption graph now indicates expected operation.

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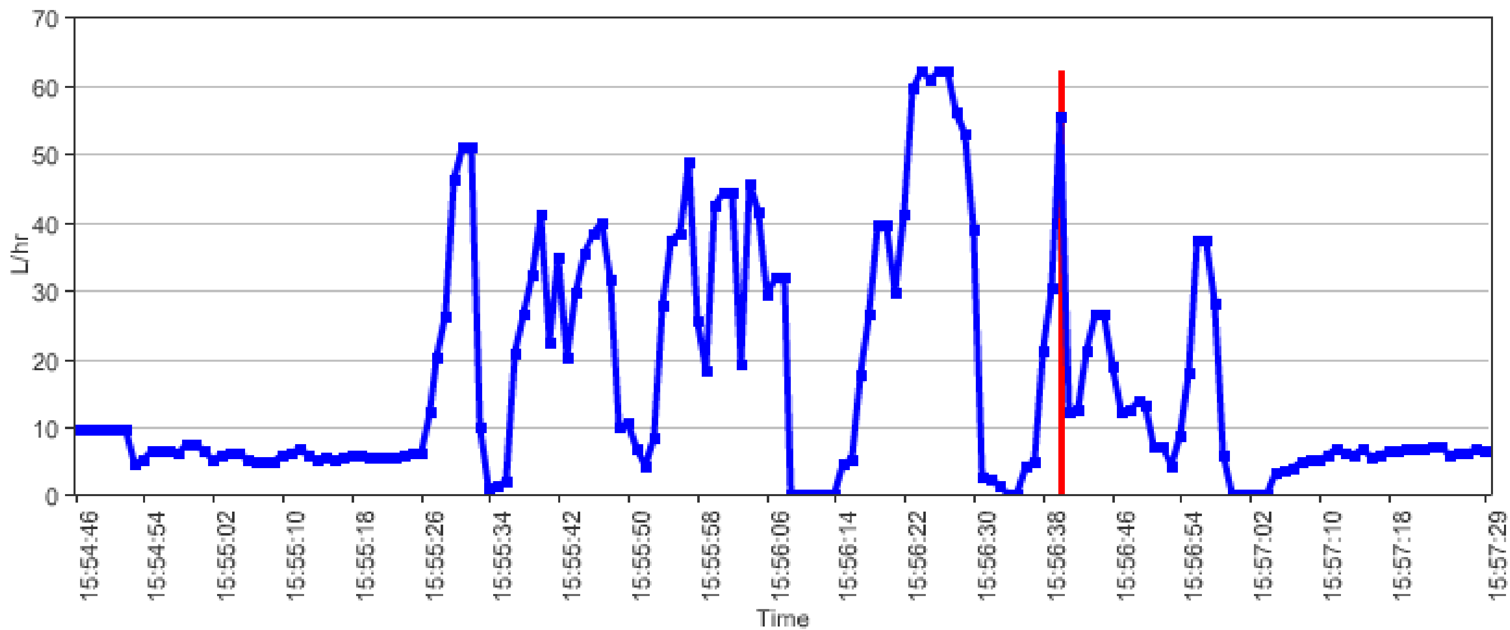
Vehicle B : Example of Fuel System Related Fault

Fault: Engine 1 - Injection Actuation Pressure System - 06/26/08 15:56:40 (UTC)

Parameter: Engine Fuel Rate

The red line indicates a fault. Click on the fault to display additional information.



Parameter	Value	Units
Wheel-Based Vehicle Speed	12.785156	kph
Engine Coolant Temperature	47.0	C°
Road Speed	15.0	kph
Engine Coolant Temperature	116.0	F°
Engine Speed	2140.375	rpm
Accelerator Pedal Position 1	86.8	%

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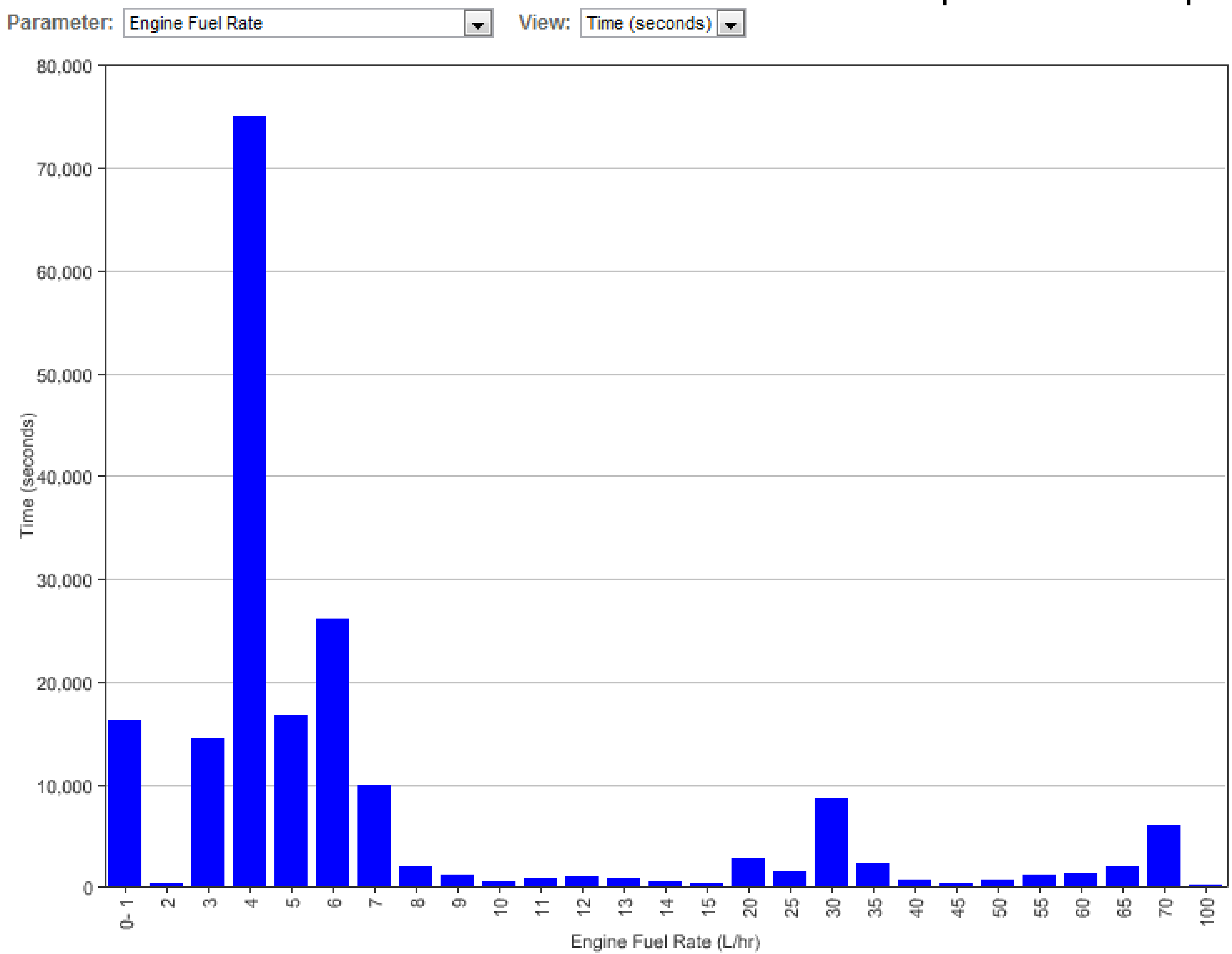
Vehicle B : Corrected Fuel Consumption After Repairs



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Our Family of DIME Products

Diagnostic **I**nformation **M**anagement **E**nvironment (DIME)

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What is the DIME?

The DIME (**D**iagnostic **I**nformation **M**anagement **E**nvironment) is a **TRL 8** end-to-end **Lifecycle and Vehicle Health Management System** complete with on-board storage, GPS tracking, wired and wireless communication interfaces. DIME enables *Connected Vehicle* applications.

The system is capable of remotely updating and upgrading the system firmware and application code within seconds even in low communication bandwidth environments. This is accomplished via the DIME Data Management Center where data is stored, analyzed, distributed and displayed.

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What is the DIME?

HARDWARE Features:

- Technical Readiness Level (TRL) 8
- **Ultra low power consumption (<25mW) in sleep mode with optional ZERO power draw configuration.**
- Low space and weight claim (approx 1.5 lbs)
- **Capable of start up and recording in less than 50ms**
- 802.11 b/g wireless interface
- 2 CAN channels capable of 1Mbps communications
- Ultra low cost hardware investment
- RS485 / RS422
- Capable of waking up from up to eight unique input sources (CAN Bias, CAN Activity, Ignition, J1708, RS232, RS422/RS485, External input, Real Time Clock)

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What is the DIME?

HARDWARE Features continued:

- RS232
- Ethernet
- **GPS (Global Positioning System)**
- **Sensor interfaces (Analog and Digital)**
- Remote management / disablement of GPS/Wireless comms
- CAISI compliant via Ethernet connection
- Forms the foundation for any diagnostic system for any vehicle platform.
- Compatible interface with mounted and mobile vehicle display systems.
- Disposable technology, low logistics footprint

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What is the DIME?

Embedded Software Features:

- **Remote configuration**
- Data compression techniques enabling performance in low bandwidth Military environments.
- **System processing of data from multiple data bus sources (CAN, J1708, RS485) simultaneously.**
- Capable of storing data in emergency power loss situations.
- **BIST (Built In Self Test)**

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THANK YOU

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President and CEO

Achieving a Systems Engineering Culture in a Science and Technology Laboratory Environment

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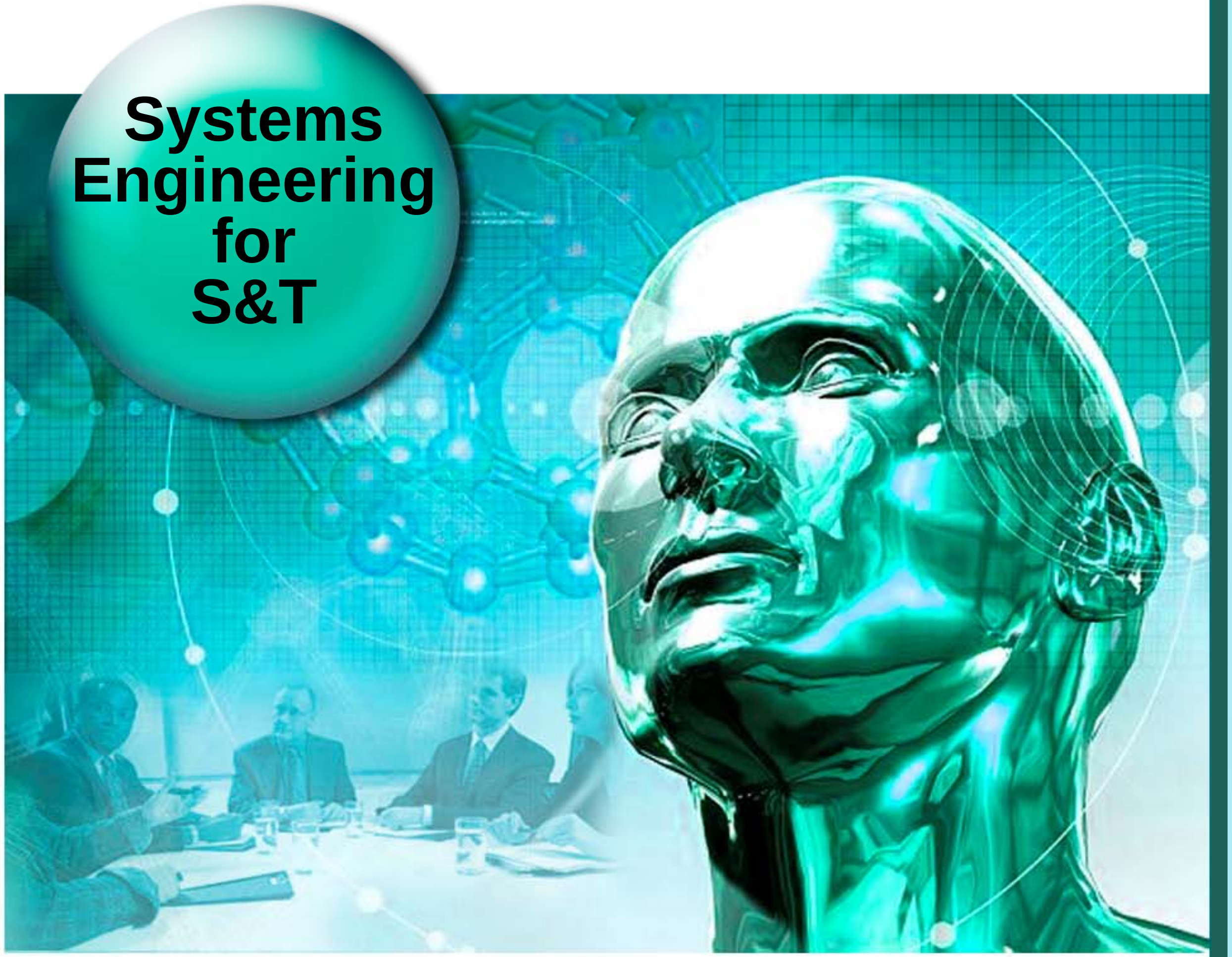
THE AIR FORCE RESEARCH LABORATORY
LEAD | DISCOVER | DEVELOP | DELIVER

88ABW-2009-4045 WPAFB PA CLEARED 090918

AFRL
THE AIR FORCE RESEARCH LABORATORY
LEAD I DISCOVER I DEVELOP I DELIVER



Achieving Systems Engineering Culture in a Science and Technology Laboratory Environment

Presentation to

NDIA Systems Engineering Conf

26-29 Oct 09

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Background

- **2008 NDIA Systems Engineering Conf**
  - **An Air Force S&T Directorate's View on Applying Systems Engineering (SE) Principles to its Programs**
  - **Introduced an ongoing effort to instantiate the practice and thinking of SE in an early R&D organization,**
    - **Process that is Streamlined, tailorable and flexible to apply the depth needed to the specific problem**

This Year's Focus: Culture and Community

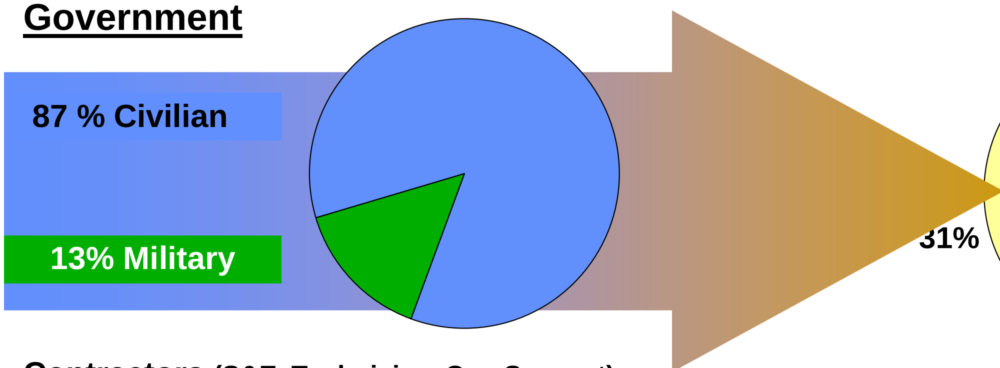
- **Share thoughts on Culture**
  - **The last thing to truly change in a transformation is the Culture**
  - **Our Team has a foundation in the streamlined process**
  - **Task at Hand is to get Systems Engineering into routine use by lab Scientists and Engineers (S&E's)**
- **Challenge:** Many Laboratory people view Systems Engineering as Acquisition oriented and stifling to creativity

What is the Culture of a Laboratory?

Lab Demographics

PERSONNEL

Government



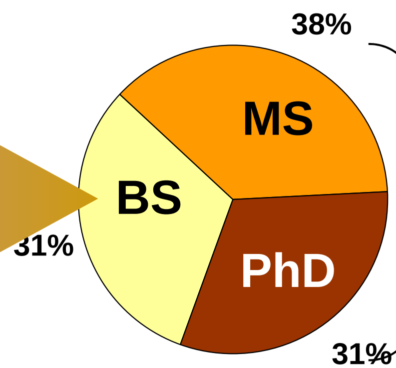
Contractors (S&E, Technician, Ops Support)

Contractor to Govt 1.2 : 1

19% Contractors have PhDs

DEGREES & SPECIALTY AREAS

76% Civilian/Military Scientist & Engineers (S&E)



- Materials Engineers
- Chemists/Chemical Engineers
- Research Physicists
- Aero Engineers
- Safety/Environmental Engineers
- Civil/Industrial Engineers
- Biologists/Microbiologists
- Mechanical Engineers
- Electrical Engineers

Typically, 70% are Task Oriented Personalities
- 70% of those task oriented personalities are Drivers

Changing Culture of the Lab

- **Changing from "Performance" objectives to "Capabilities" Focused objectives**
- **Continue to Restructure the Organization**
- **Emphasizing Integrated Programs with other organizations**
- **Increased competition for resources**

Moving toward a prioritization of the entire portfolio

Range of R&D at the Lab

- **Basic Research to Advanced Technology Development (ATD) and Manufacturing Technology**
  (6.1 – 6.3 type of Funding)
- **AFRL Designated Core Processes (CP)**
  - **CP-1 Generate Understanding of S&T Opportunities**
  - **CP-2 Deliver Needed Technology Options**
  - **CP-3 Innovate Solutions to Urgent Needs**
- **Focused Long Term Challenges**

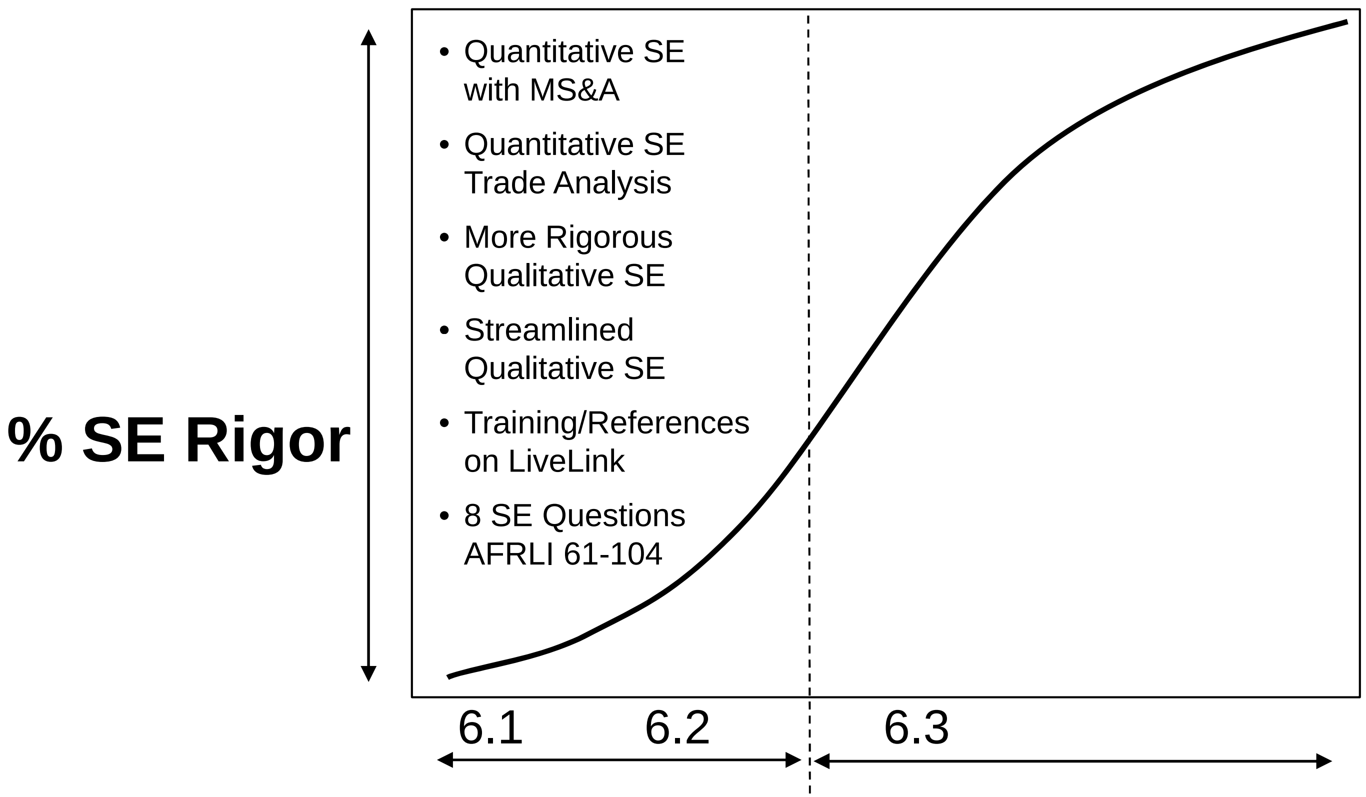
The Lab Scientists and Engineers deal with everything from Basic Research to fielded warfighter technology solutions

Educated, Adaptable, Very Busy

What then is our Culture?
"Laboratories are Different"

- **Great People**
  - Heritage of government service, asking "What does the Air Force need?"
  - Strong history of emphasis on scientific advances and creativity
  - In-Depth relationships have been built across organizations based on technical expertise
  - Tend to be independent and self-guided
- **Dealing with Dramatic Changes**
  - Performance Based to Capability Based
  - Many Organizational and Technical Variables
  - Higher HQ policies and instructions impinge on scientists' view of mission
- **Recently faced with Constrained Resources**

How do we respond to this culture?

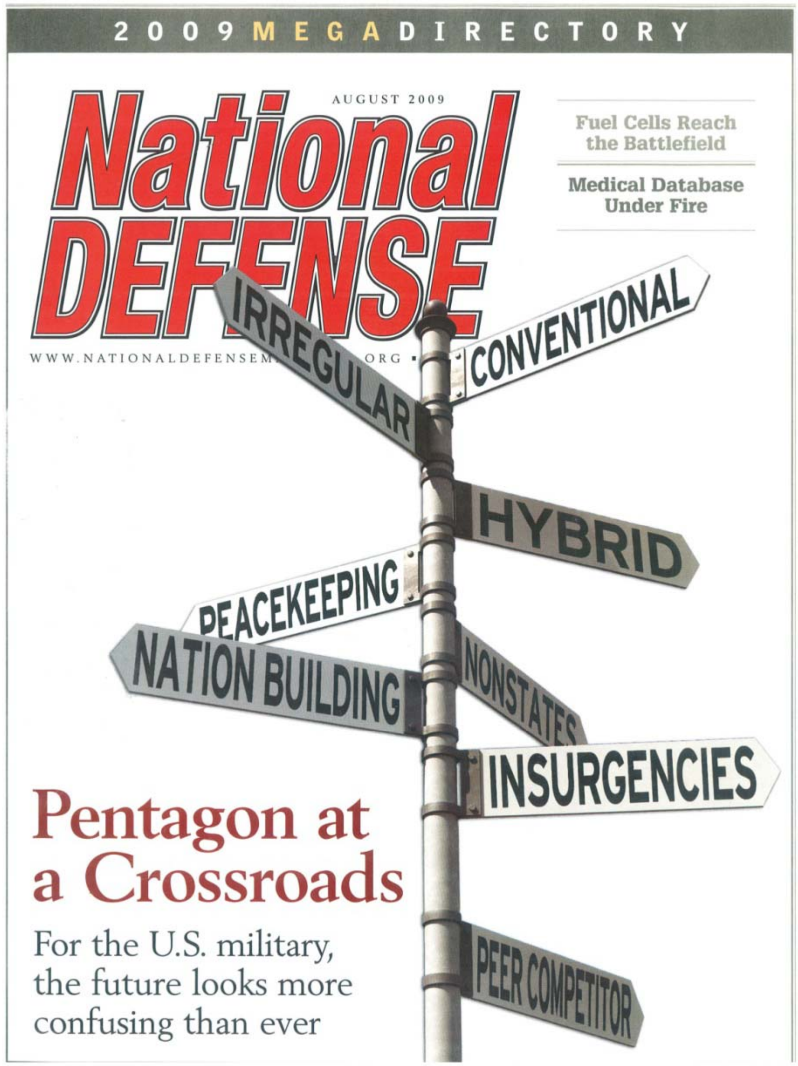


“The Conversation”

Some without tools

Some without tools or tools tailored to need

Timeliness of Culture Issue


2009 MEGA DIRECTORY

AUGUST 2009

National DEFENSE

WWW.NATIONALDEFENSEM ORG

Fuel Cells Reach the Battlefield

Medical Database Under Fire

IRREGULAR
CONVENTIONAL
HYBRID
PEACEKEEPING
NATION BUILDING
NONSTATES
INSURGENCIES
PEER COMPETITOR

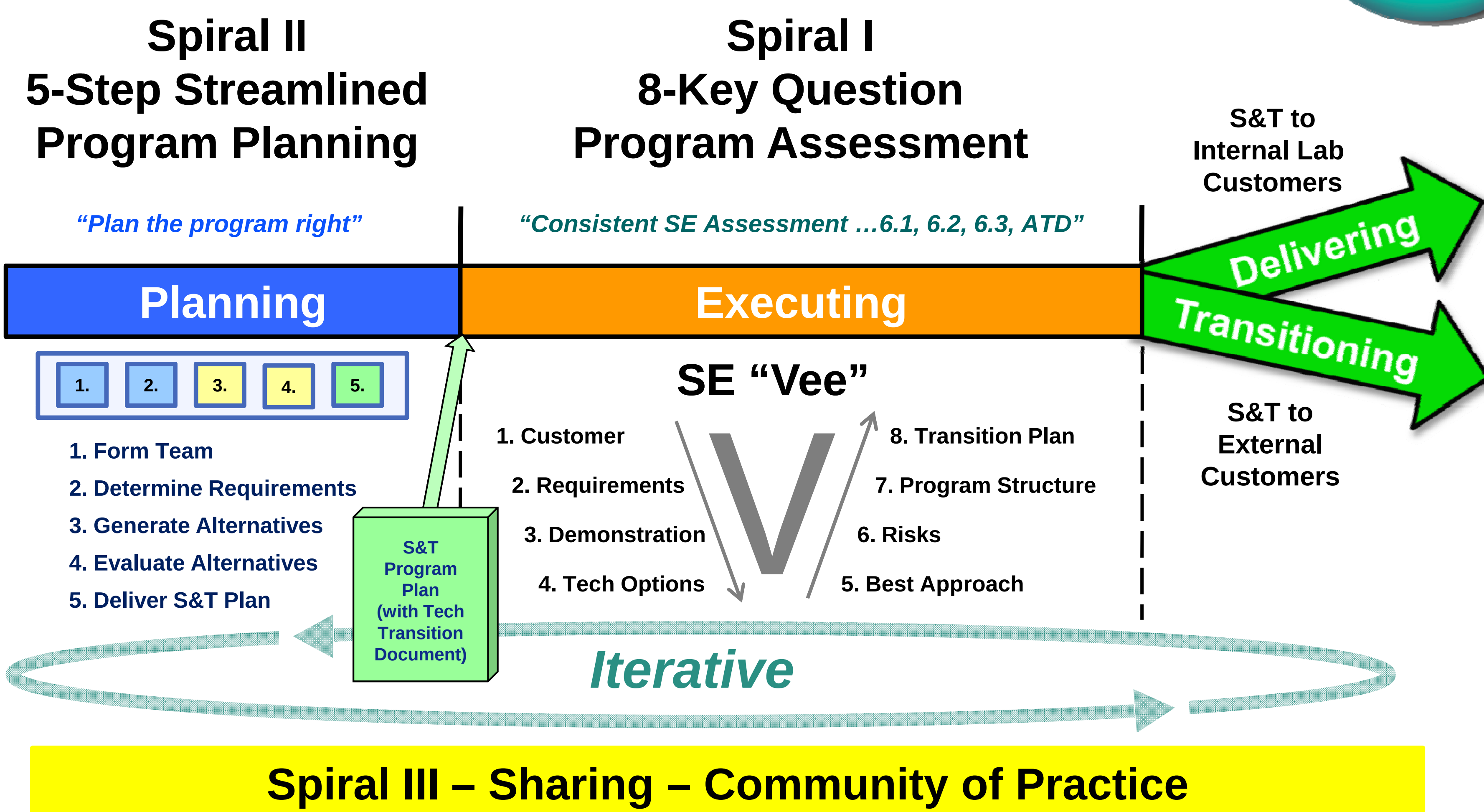
Pentagon at a Crossroads

For the U.S. military, the future looks more confusing than ever

How can SE Help in Such a Culture?

- <u>DoD</u> SE emphasis came out of Acquisition concerns
- <u>Lab folks</u> feel applying SE to S&T seems like a stretch
- <u>We</u> Believe:
  - Streamlined process fits our culture
    - Focused, Succinct, Tailored, Affordable, Owned by the SME
    - Applies across the Program Life Cycle, but EMPHASIS on the Program Planning phase (Greatest Benefit)
  - Hands-on, early experience “sells” the value of the process / methodology
  - Learning occurs during the process, the process is an opportunity for discovery
  - This is a creative activity

Our Current Approach



Current Streamlined Systems Engineering Process

Step 1	Step 2	Step 3	Step 4	Step 5
Form Team	*Determine Requirements*	*Generate Alternatives*	*Evaluate Alternatives*	*Deliver S&T Plan*
Do: • Define Problem • Identify all stakeholders • Establish Team	• Define requirements • Define tech challenges • Define S&T Exit Criteria (KPP sets) • Validate with customer	• Understand applicable state-of-the-art & near term technologies • Brainstorm different solution approaches	• Compare alternatives across req'ts / S&T exit criteria • Solicit customer approval for proposed solution	• Finalize AF Problem / Goal / Solution Objectives • Prepare for intended action course
Document: ❑ Problem Definition ❑ Team Directory (include roles & responsibilities) ❑ Team Charter (optional)	❑ Prioritized Requirement Set - Performance - Affordability - Producibility - Reliability - Supportability ❑ S&T Exit Criteria	❑ Alternative Definitions	❑ Tech Readiness Assessment ❑ Manufacturing Readiness Assessment ❑ Risk Analysis ❑ Value Analysis ❑ Cost Estimate ❑ Schedule / Key Milestones	❑ AF Problem / Goal / Solution Objectives statement ❑ Program Roadmap ❑ Action Plan

Based on S&T IPPD Process (Version 3, 2002)

Approach to Affecting the Culture

Based on the Streamlined SE process

- **View S&E Program Managers as “internal” customers**
  - **Tailor approach for each specific project**
- **Emphasize initial, manual, self-directed approach**

  (Computer can be a distraction)
  - **Hands on, with facilitated guidance**
  - **First hand experience**
  - **Familiarity and ownership of process**

Tools to Implement the Approach

Air Force Research Laboratory

Materials and Manufacturing Technology Directorate

Guide for Applying a

Streamlined Systems Engineering (SE) Approach

To Program Planning

Spiral 2 of the AFRL/RX SE Initiative

Version 1.0
24 August 2009

Air Force Research Laboratory
Materials and Manufacturing Technology Directorate

Self-Sufficiency Workbook for Applying a
Streamlined Systems Engineering (SE) Approach
to Program Planning

Spiral 2 of the AFRL/RX SE Initiative

Version 1.0

24 August 2009

1

Tools to Implement the Approach

- **Guidebook – Users manual for the Streamlined Process (*description of "What Is It?"*)**
- **Workbook – Means of capturing the preliminary data and decisions, (*the "How to Do It"*)**
  - **Can be used by informal team <u>or</u> individual Portfolio / Program / Project Manager**
  - **First Evaluation can provide basis for Approval Decision to proceed with Team based process – or provide sufficient information to the PM (Go/No Go)**
  - **Subsequent Streamlined Process work with full team results in detailed project definition / with Action Plans and Proposals**

Guidebook Page 11

Applying AFRL/RX Streamlined SE Core Process

Figure 3 illustrates the RX Streamlined SE Core Process and indicates that it is a relatively simple process that generates five products.

	Step 1	Step 2	Step 3	Step 4	Step 5
	Form Team	*Determine Requirements*	*Generate Alternatives*	*Evaluate Alternatives*	*Deliver S&T Plan*
Do:	• Define Problem • Identify all stakeholders • Establish Team	• Define requirements • Define tech challenges • Define S&T Exit Criteria (KPP sets) • Validate with customer	• Understand applicable state-of-the-art & near term technologies • Brainstorm different solution approaches	• Compare alternatives across req'ts / S&T exit criteria • Solicit customer approval for proposed solution	• Finalize AF Problem / Goal / Solution Objectives • Prepare for intended action course
Document:	❑ Problem Definition ❑ Team Directory (include roles & responsibilities) ❑ Team Charter (optional)	❑ Prioritized Requirement Set - Performance - Affordability - Producibility - Reliability - Supportability ❑ S&T Exit Criteria	❑ Alternative Definitions	❑ Tech Readiness Assessment ❑ Manufacturing Readiness Assessment ❑ Risk Analysis ❑ Value Analysis ❑ Cost Estimate ❑ Schedule / Key Milestones	❑ AF Problem / Goal / Solution Objectives statement ❑ Program Roadmap ❑ Action Plan

Figure 3. AFRL/RX Streamlined SE Core Process

Product 1 – Problem Definition and Team Directory

Product 2 – Prioritized Requirements and S&T Exit Criteria

Product 3 – Alternative Solutions

Product 4 – Evaluation of Alternatives

Product 5 – S&T Plan

11

Guidebook Discussion
Step 1 – Form Team

Step 1 Description	Step 1 Products
The Program Manager schedules a Team Orientation Meeting to review team member roles, ensuring that they are understood and obtaining commitments from Customer Representatives and Key Team Members. The SE Facilitator presents the SE Core Process and a Project Overview by conducting a review of all elements of Homework #0 with the team.	Product 1 under Step 1 of the Streamlined SE Process is a Problem Definition and Team Directory. Homework 1 is the initial Requirements and S&T Exit Criteria worksheets (Form 1.1)
Homework #1 begins with the SE Facilitator providing a written overview of the Streamlined SE Core Process and the project or program as documented in Homework #0 to all Team Members for their review.	
Next, all Team Members prepare worksheets for the Air Force Problem, Requirements and S&T Exit Criteria and then provide them to the SE Facilitator. These worksheets are available in the RX SE Self-Sufficiency Workbook.	
The SE Facilitator compiles the Requirements defined by team members, and forwards them to the Program Manager.	
Finally, the Program Manager obtains initial customer inputs on the Requirements developed by the team.	

Workbook, Two Approaches

- **Individual or Informal Initial Review**
- **Full IPT Plan**


Air Force Research Laboratory
Materials and Manufacturing Technology Directorate

Self-Sufficiency Workbook for Applying a
Streamlined Systems Engineering (SE) Approach
to Program Planning

Spiral 2 of the AFRL/RX SE Initiative

Version 1.0

24 August 2009

Workbook Pg 4, Initial Review

Project Exploration Decision

- **(PM) Exploration and Info Gathering**
  - **White Papers**
  - **Presentations**
  - **Initial Discussions with SE Facilitator**
  - **Strawman Description of AF Problem**
    - **Use Form 0.1 *'AF Problem, Requirements, S&T Exit Criteria'***

* Expanded discussion of this element of the RX SE Core Process is available in the RX SE Core Process Guide

4

Workbook PM Initial Review

Project Exploration Decision

Form 0.1 *'AF Problem, Requirements, S&T Exit Criteria'*

Program Manager: ________________________

Worksheet for AF Problem, Requirements, S&T Exit Criteria

Provide a "Problem Statement" that captures major issues and scopes problem space. What is the Air Force problem to be solved? Just 1 or 2 Sentences.

____

____

____

____

____

____

5

Workbook Pg 13

* Step 1: Form Team

- (PM) Kickoff/Team Orientation Meeting
  - Assumes Project Approved to Use SE Streamlined Core Process
  - Ensure Team Member Roles are Understood
  - (SE Facilitator) Presents Core Process and Project Overview
  - (PM) Gains Commitment from Customer Rep & Key Team Members

* Expanded discussion of this element of the RX SE Core Process is available in the RX SE Core Process Guide

Workbook pg 15

Step 1: Form Team

Form 1.1 'AF Problem, Requirements, S&T Exit Criteria'

IPT Member Name:___________________________
Member Role: _Team Members_____

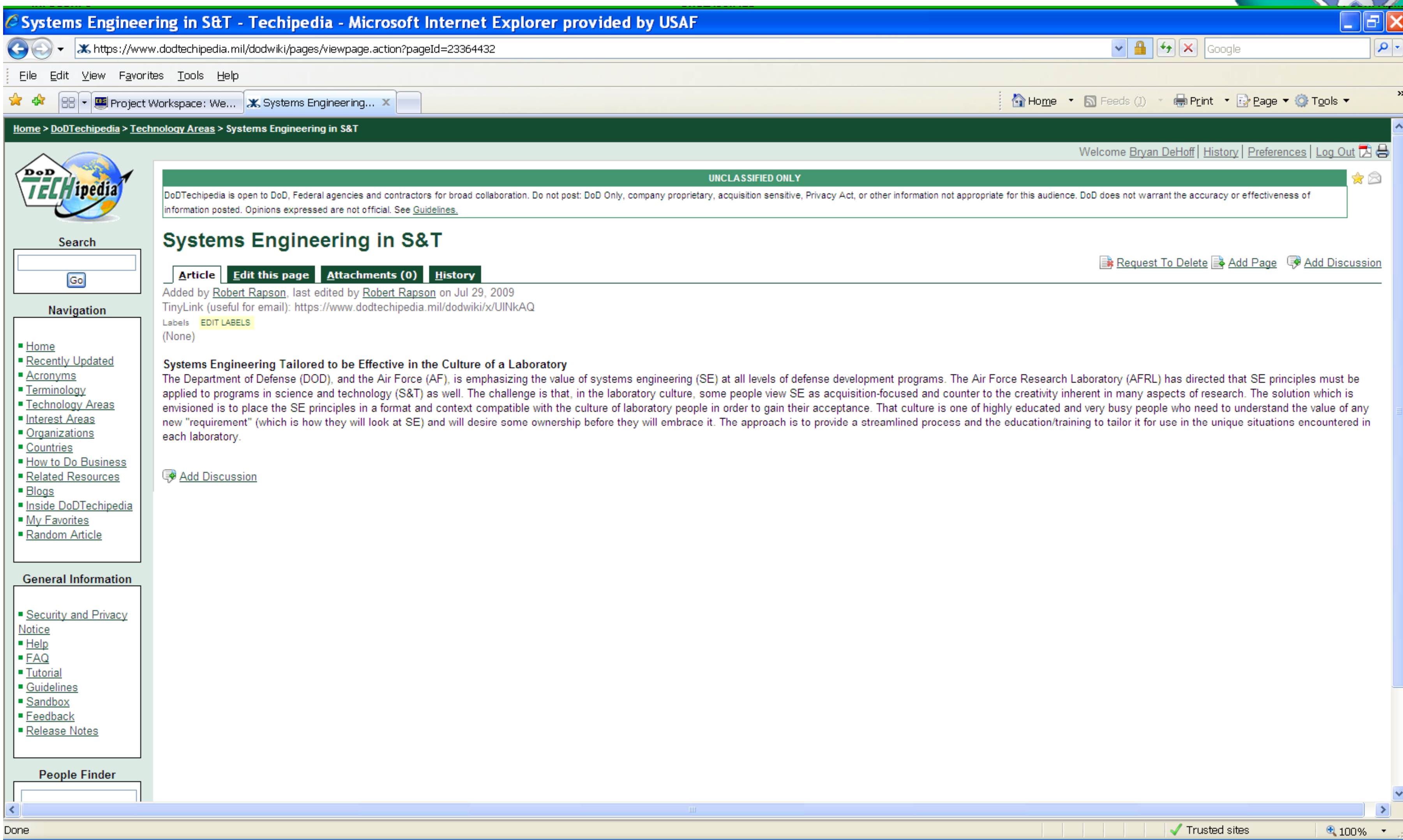
Worksheet for Problem, Requirements, S&T Exit Criteria

Provide a "Problem Statement" that captures major issues and scopes problem space. What is the Air Force problem to be solved? Just 1 or 2 sentences.

Summary and Conclusions

- **Instantiation of SE in S&T Culture is continuing**
  - **2008 – Streamlined Process and Early Applications**
  - **Today – Hands on approach to reach our culture, and enhance the disciplined creativity of discovery**
- **Invitation to the Community (SE and NDIA)**
  - **Very little literature on the application of SE to this S&T culture**
  - **DoD emphasizing Communities of Interest**
  - **We have a "Systems Engineering in S&T" Technology Area in DoDTechipedia**
    - **https://www.dodtechipedia.mil/dodwiki/x/UINkAQ**
  - **Please visit and continue the conversation**

DoD Techipedia Screen



Systems Engineering in S&T - Techipedia - Microsoft Internet Explorer provided by USAF

https://www.dodtechipedia.mil/dodwiki/pages/viewpage.action?pageId=23364432

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Project Workspace: We... | Systems Engineering...

Home | Feeds (J) | Print | Page | Tools

Home > DoDTechipedia > Technology Areas > Systems Engineering in S&T

Welcome Bryan DeHoff | History | Preferences | Log Out

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Systems Engineering in S&T

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Added by Robert Rapson, last edited by Robert Rapson on Jul 29, 2009

TinyLink (useful for email): https://www.dodtechipedia.mil/dodwiki/x/UINkAQ

Labels EDIT LABELS

(None)

Systems Engineering Tailored to be Effective in the Culture of a Laboratory

The Department of Defense (DOD), and the Air Force (AF), is emphasizing the value of systems engineering (SE) at all levels of defense development programs. The Air Force Research Laboratory (AFRL) has directed that SE principles must be applied to programs in science and technology (S&T) as well. The challenge is that, in the laboratory culture, some people view SE as acquisition-focused and counter to the creativity inherent in many aspects of research. The solution which is envisioned is to place the SE principles in a format and context compatible with the culture of laboratory people in order to gain their acceptance. That culture is one of highly educated and very busy people who need to understand the value of any new "requirement" (which is how they will look at SE) and will desire some ownership before they will embrace it. The approach is to provide a streamlined process and the education/training to tailor it for use in the unique situations encountered in each laboratory.

Add Discussion

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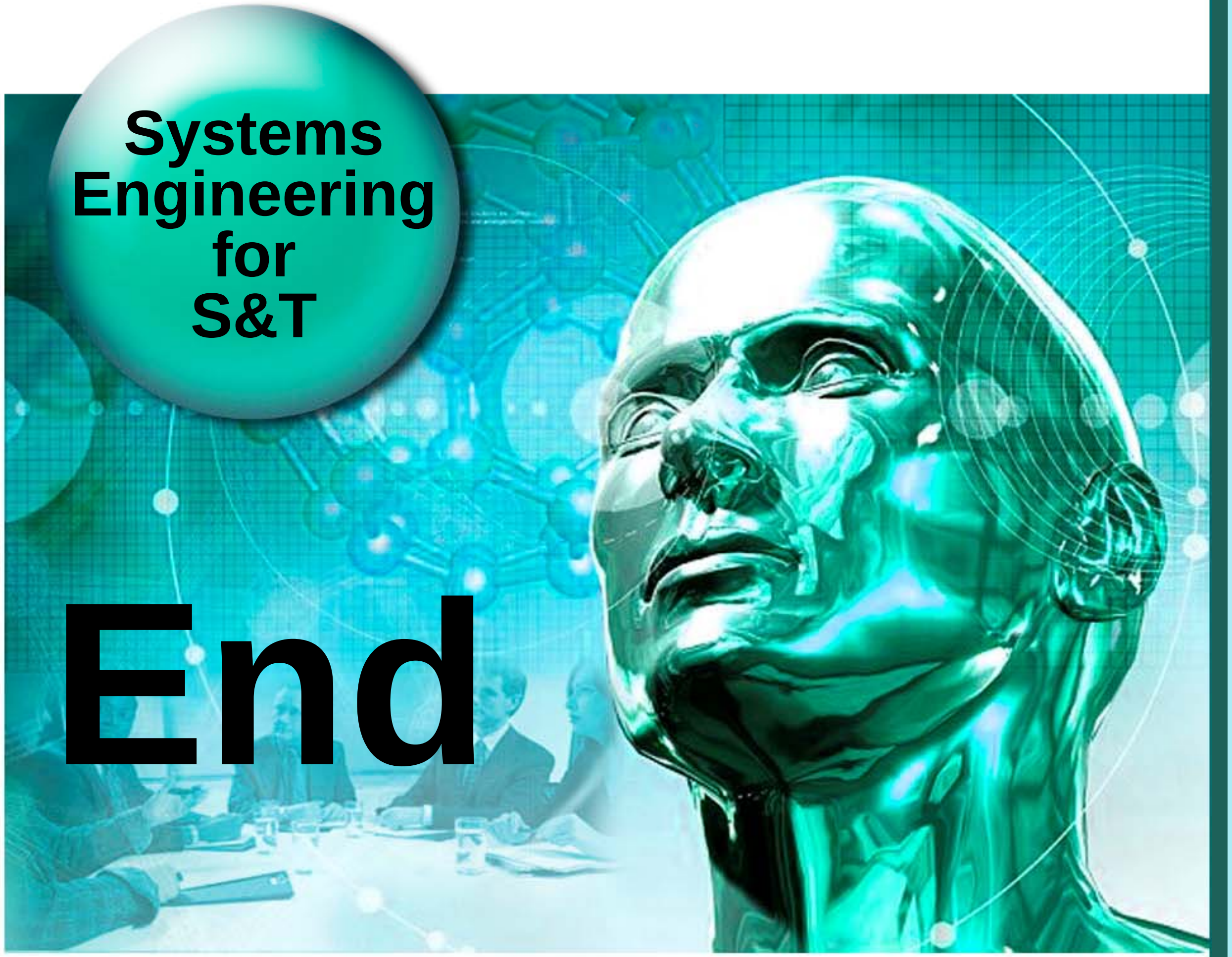


Achieving Systems Engineering Culture in a Science and Technology Laboratory Environment

AFRL
THE AIR FORCE RESEARCH LABORATORY
LEAD | DISCOVER | DEVELOP | DELIVER

Presentation to

NDIA Systems Engineering Conf

26-29 Oct 09

Software Test & Evaluation Summit/Workshop Review

The Summit/Workshop was facilitated by the NDIA Systems Engineering Division's Software Industry Experts Panel and the Developmental Test and Evaluation Committee

Basis for SW T&E Summit/Workshop

- NDIA SE Division's SW Committee report completed in September 2006
  - Top Software Engineering Issues in the Defense Industry
- Key Theme of the Report

  Current approaches for acquiring, developing, verifying and sustaining software enabled systems are inadequate to deal with the complexities of a dynamic and changing acquisition environment.
- Requested to identify top five issues
  - Actually came up with seven

Top Seven SW Engineering Issues

1. The impact of requirements upon software is not consistently quantified and managed in development or sustainment.
2. Fundamental system engineering decisions are made without full participation of software engineering.
3. Software life-cycle planning and management by acquirers and suppliers is ineffective.
4. The quantity and quality of domain-knowledgeable software engineering expertise is insufficient to meet the demands of government and the defense industry.
5. Traditional software verification techniques are costly and ineffective for dealing with the scale and complexity of modern systems.
6. There is a failure to assure correct, predictable, safe, secure execution of complex software in distributed environments.
7. Inadequate attention is given to total lifecycle issues for COTS/NDI impacts on lifecycle cost and risk.

Issue 5 – Description

Traditional software verification techniques are costly and ineffective for dealing with the scale and complexity of modern systems discussion points:

- Over-reliance on testing alone rather than robust SW verification techniques.
- Manual testing techniques are labor-intensive, scale poorly, and are unproductive relative to the large investment of resources.
- Compliance-based tests do not adequately cover risks or failure conditions.
- Tests are over-documented with disproportionate effort on detailed procedures.
- Education, training, certifications are inadequate to develop effective test skills.

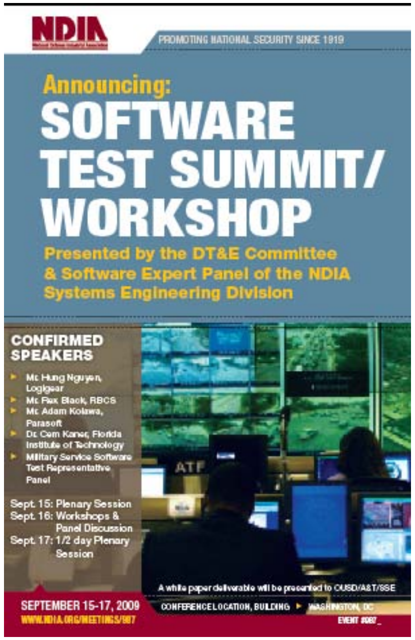
Issue 5 – Recommendation

Study current software verification practices in industry, and develop guidance and training to improve effectiveness in assuring product quality across the life cycle.

– Sponsor a study of state-of-the-practice verification and testing approaches.
– Review/update testing policies and guidance to emphasize robust, productive approaches that maximize ROI.
– Review adequacy of verification plans/approaches early in the acq. life cycle.
– Emphasize skilled investigation throughout the life cycle, based on coverage, risk mitigation, high volume automation.
– Strengthen curricula, training, certifications, career incentives for testing roles.

Summit/Workshop Objective

To recommend policy and guidance changes to the Defense enterprise to emphasize robust and productive software Testing and Evaluation (T&E) approaches in Defense acquisition.



Location & Attendance

- Hotel: Hyatt in Reston Town Center, VA
- Dates: September 15 -17, 2009
- 110 Registered Attendee
  – 9 no-shows
  – Approx. 80 stayed to the end of last day!
- Better than expected participation!

Day 1 Agenda

8:00 Introduction – Why this Summit/Workshop

8:10 Government Presentations

9:50 Break

10:15 DoD Industry Panel

11:45 Lunch & Speaker

12:45 SW Test Industry Experts

2:25 Break

2:50 SW Test Industry Experts

4:30 Adjourn

Day 2 Agenda

8:00 Re-Cap Day 1

8:10 DoD Services Panel

9:45 Introduction of Workshops

   10:00 Break

10:30 Workshops

   12:00 Lunch & Speaker

1:00 Workshops

   2:30 Break

3:00 Workshops

4:30 Adjourn

Day 3 Agenda

8:00Re-Cap Day 2

8:10 Introduction of Workshop Leaders

8:15 Presentation of Issues and Recommendation by Workshop Leaders

9:45 Break

10:00 Way Forward Discussion & Final Q&A's

– Final Summit/Workshop Product defined

11:00 Adjourn

Speakers Morning Day 1

Framing the DoD Software T&E Issues

- Dr. Ernest A. Seglie, Chief Science Advisor, DOT&E
- Mr. Chris DiPetto, Acting Director, DT&E
- Ms. Kristen Baldwin, Director for System Analysis, OD, DR&E

Speakers Morning Day 1

Panel: Framing the Industry Software T&E Issues

- Mr. Edgar Doleman, CSC
- Mr. Bruce Casias, Raytheon
- Mr. Tom Wissink, Lockheed Martin

Speakers Afternoon Day 1

- Lunch: Mr. Paco Hope, Cigital
  - Software Security in Defense T&E
- Dr. Cem Kaner, Florida Institute of Technology
  - Challenges in the Evolution of Software Testing Practices in Mission-Critical Environments
- Dr. Adam Kolawa, Parasoft
  - Software Development Management
- Mr. Rex Black, RBCS
  - Risk-Based Testing
- Mr. Hung Nguyen, Logigear
  - Software Testing & Test Automation

Speakers Morning Day 2

Panel: Framing the Services Software T&E Issues

– Dr. James Steilein, US Army Test and Evaluation Command
– Dr. Steve Hutchison, Defense Information Systems Agency (DISA)
– Mr. Mike Nicol, Aeronautical Systems Center, Wright-Patterson AFB

Lunch: Mr. Richard Kuhn, NIST

– Combinatorial Testing

Remainder of Day 2

Workshops – Three Key Challenge Areas (KCA):

1. How Much T&E is Enough
   - Risk considerations, Installed System T&E, Instrumentation, Reliability, Completion Criteria, Coverage and C&A
2. Lifecycle and End-to-End Software Testing
   - How does SW T&E get involved in early development (i.e. left-hand side of the V-model and I&T deliverables
3. Changing Paradigms
   - Open Architecture, COTS, SOA, SoS, SaaS, Legacy plus New, Security

Remainder of Day 2

Workshops – Four Focus Areas for each KCA:

1. Review, revise, improve RFP Language (Including T&E activities/deliverables in Competitive Prototyping)
2. Training, Competency Model, Human Capital
3. Policy, Guidance & Standards
4. Tools/Automation, Methodologies & Processes

Results of Workshop – Raw Data

Issues

1. Workshop #1 – 108
2. Workshop #2 – 51
3. Workshop #3 – 20

Total – 179

Participants

1. Workshop #1 – 30
2. Workshop #2 – 31
3. Workshop #3 – 25

Total – 86

Recommendations

1. Workshop #1 – 44
2. Workshop #2 – 29
3. Workshop #3 – 13

Total – 86

Results of Workshop – Raw Data

Recommendations by Focus Area

- 17 for FA #1 Revise/Improve RFPs & T&E Deliverables
- 23 for FA #2 Training, Human Capital, Competency Models
- 22 for FA #3 Policies, Guidance & Standards
- 17 for FA #4 Tools/Automation, Methodologies & Processes
- 7 for FA #5 Costs, Software, Studies, Organization

Way Forward

This is a Joint effort of the NDIA's SE Division DT&E Committee and the Software Industry Experts Panel

1. Workshop #1 Team to complete Recommendation Generation by October 9 **(Done)**
2. In parallel with the Item 1 generate draft outline for the SW T&E Summit/Workshop White Paper **(Done)**
3. Review and correlate Workshops 1, 2 and 3 issues and recommendations
   – Update White Paper outline if needed
4. Generate Initial White Paper
   – Completion goal – December 4, 2009

Q & A

SW T&E Summit/Workshop Presentations:

www.ndia.org/Divisions/Divisions/SystemsEngineering/Pages/Test_and_Evaluation_Committee.aspx

NDIA
National Defense Industrial Association

Raytheon
Customer Success Is Our Mission

Successful First AESA Deployment through Application of Systems Engineering

Terry Duggan
Scott Nichols
Christopher Moore
29 October 2009

Outline

- Background
- Approach
- Systems Engineering Activities
- Results of Analyses
- Readiness Assessment
- What Happened
- Lessons Learned

Background

- Raytheon developed a new AESA radar for the F/A-18E/F aircraft under contract to Boeing for the US Navy
- After completion of OPEVAL and training, US Navy planned to deploy two full squadrons of 12 jets each with new AESA radars for a six month deployment in support of OIF/OEF.
  – One squadron on the USS Reagan deployed from San Diego, CA and one on the USS Roosevelt deployed from Norfolk, VA.
- US Navy/Boeing/Raytheon Team dedicated to deployment success!

Used a Systems Engineering Approach to Address All Aspects of First Deployments

Raytheon

- Created a joint team of Navy, Boeing and Raytheon representing the various disciplines required for a successful deployment
  - Squadron Commanders, pilots, maintainers, engineers, software engineers, field support technicians, repair management, etc
- Determined Success Criteria
  - Stability of hardware
  - Tactical performance
  - Inputs from Commanders
  - Inputs from Navy Maintainers
  - Inputs from USN PMO/DAPML
- Visited each of the 2 squadrons on each coast to conduct pre-deployment readiness review/coordination sessions
- Assess all Logistics Elements
- Developed Action Plan
  - Developed a readiness checklist
  - Spares, repairs, retrofits, IETMs, etc
- Worked Plan
- Supported Deployment
- Prepared Lesson Learned

Using Systems Engineering Techniques Was Able to Assess the Hardware/Software Readiness of the New Radar

Raytheon

- Hardware Readiness
  - Evaluate maturity of hardware to be deployed
  - Determined the minimal configuration of each radar LRU (WRA).
  - Identified hardware that needed to incorporate retrofits for radars to be deployed
- Evaluate Performance of Tactical Software
  - Analyzed OPEVAL and training data of various mission profiles
  - Analyzed data on various tactical software releases
  - Analyzed current problems/anomalies reported from fleet and pilots
  - Developed procedure to work-around critical anomalies
- Evaluate performance of BIT software
  - Ability to accurately Fault Detect
  - Ability to accurately Fault Isolate
  - False Alarm rate

Systems Engineering Assessment of All Logistics Elements

- Maintenance Concept
- Supply Support
- Repairs
- Depot Status
- Tech Reps
- IETMS
- PHST
- Maintenance Training
- Reliability
- Support Equipment
- Tools

Results of Analyses

Raytheon

Priorities

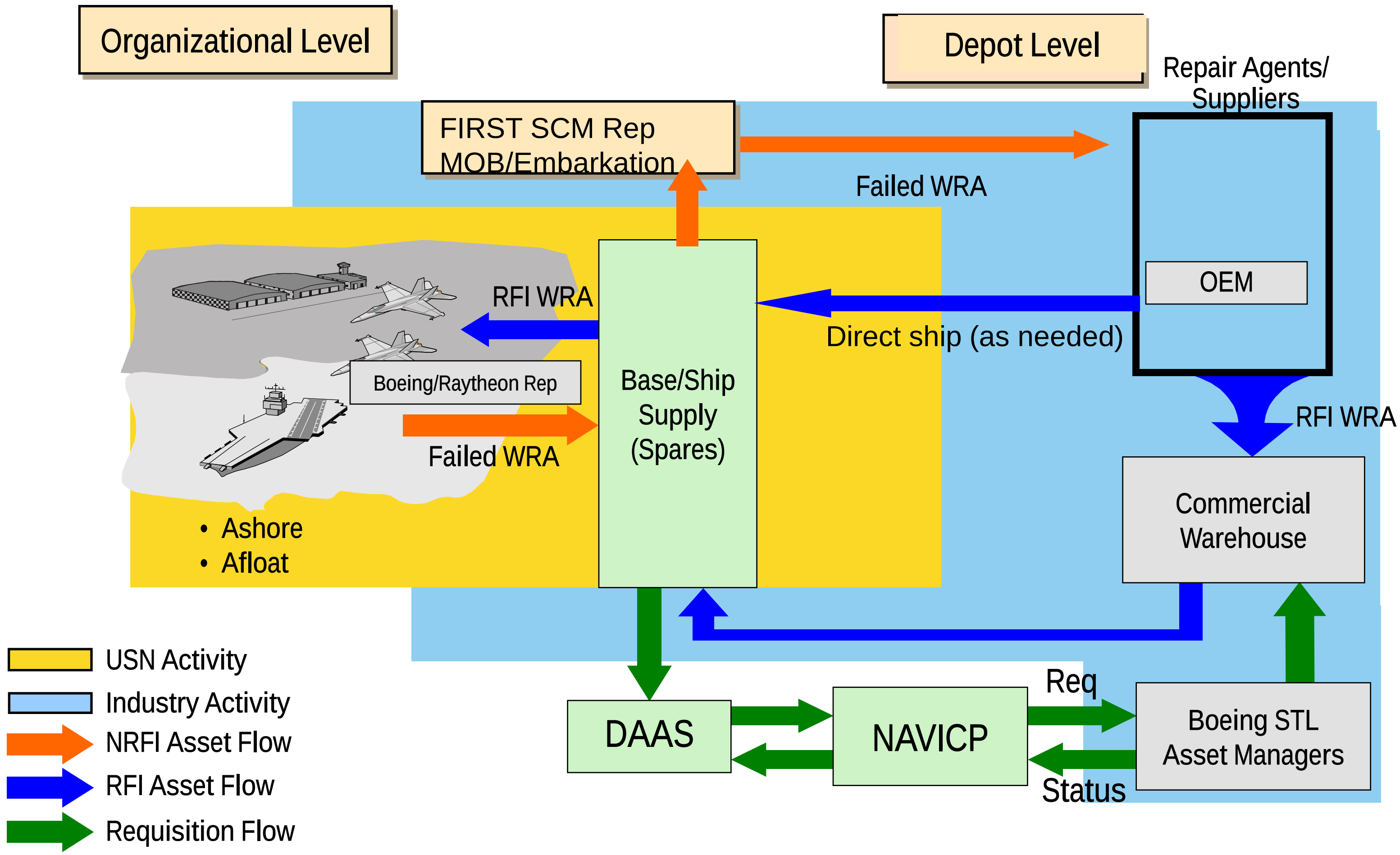
	H/W List of Items	Comment	High	Med	Low
1	Antenna Filter	Special tools and training will be needed. Difficult to do on airplane			√
2	Reload Spares with H4 OFP	GPP, ARI, PPM, SNBC, and MFA/BSC need to be loaded with H4, 8P	√		
3	Check busbar torques	Should check for torque value		√	
4	Spare IRR Attach bolts	Top and bottom bolts (different bolts) have been know to strip and bind		√	
5	MFA Attach bolts	- check torque value - spare bolts - spare green loctite		√	
6	FC Cables	extra set of FC cables for IQ and AL between CISP and REX			√
7	Spare RF Green Y Cable	RF cable between Antenna and REX			√
8	MFA Busbar Screws	see parts list		√	
9	PCU Repair kit	upper bolt repair kit		√	
10	Spare IRR's	When the MSS bolts fail, there are two ways to fix. 1- swap IRR 2- complete teardown of the IRR (risk of break if maintained improperly)	√		
11	Cover Hinge Loctite	CISP, REX, RPS[illegible]		√	
12	WRA Shipping containers				√
13	BIT Tool	Laptop which contains the BIT Tool to help troubleshoot		√	
14	Check CAL information	Run the BIT CST and TR Element tests on the airplanes to trend performance		√	
15	Subrack Spare Parts	Special tools and parts will be needed--1/4 Turn Cover Fasteners, Attach bolts, EMI gasket, QD's (module and subrack)	√		
16	Review A/C "Grey" failures	Some A/C were having issues at power up (FCAL not connecting) and Arrays failing and healing itself. It hasn't officially failed.		√	
17	Cable assembly for support pan	in case it breaks			√

Mitigation:

- Recommend a spare radar
- Provide consumable parts for deployment

AESA Maintenance Concept

Raytheon

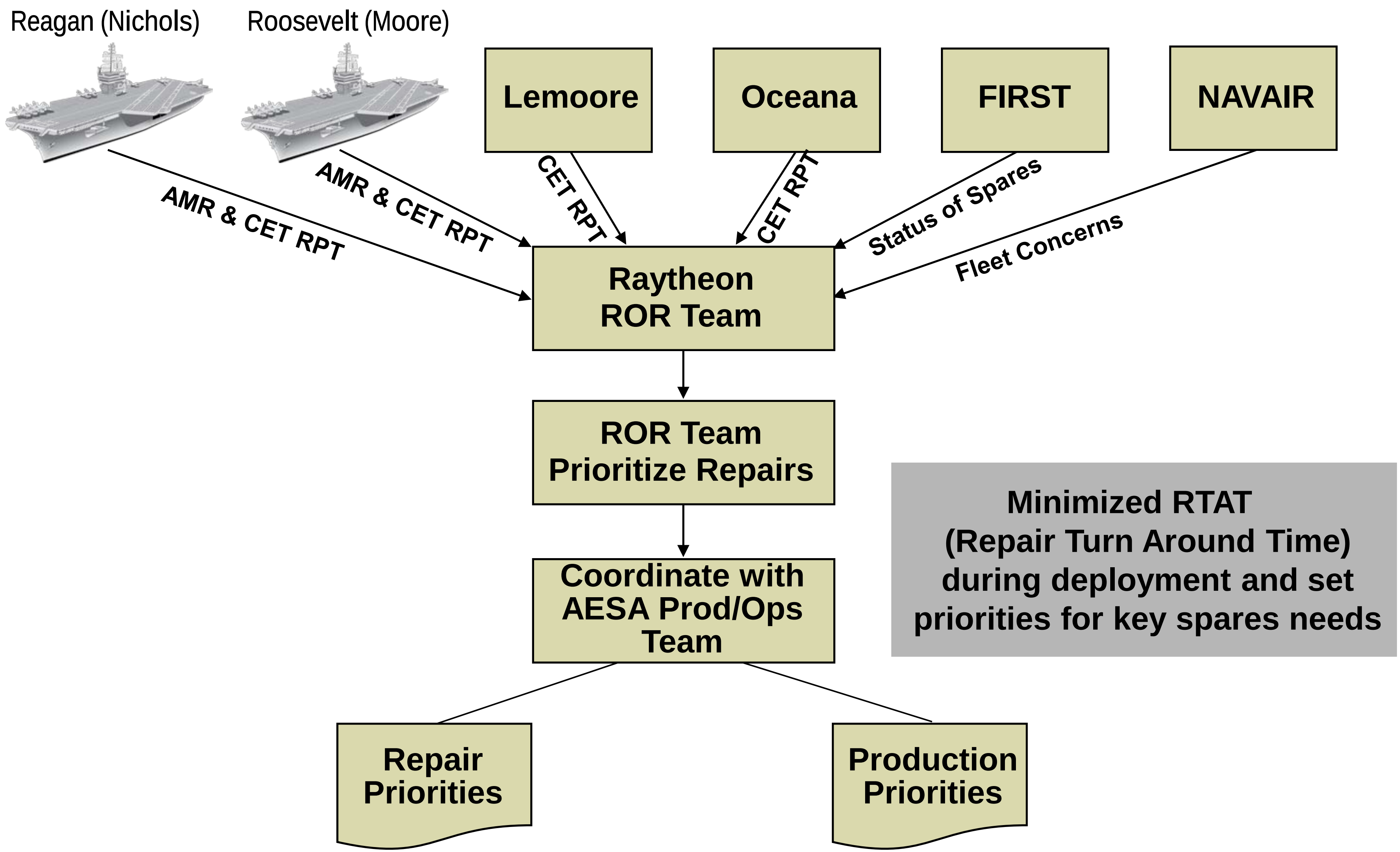


Developed Plan to Address Items in the Readiness Assessment

Raytheon

- Hardware upgrades
  - Plan for retrofitting Hardware
- Software Upgrades
  - Identified required version of tactical software (OFP)
  - Identified issues with software performance
  - Published new instructions for Pilots to mitigate or eliminate problems
- Generated a minimal Spares List
  - WRAs
  - Consumables
  - Special tools
- Ensured adequate repair contract in place
  - Arranged for surge capacity
- Identified Additional Maintainer Training
- Established a 24 hour help desk
- Established contract for tech reps to go to sea
- Provided list of required Support Equipment
- Communicated plan and status to all stakeholders weekly/daily

24 Hour Help Desk/Repair Communication Flow Process Implemented



Results of VFA-22 Squadron Deployment

Raytheon

- Deployed on cruise with 12 F/A-18F aircraft
- 6 month deployment (May to November)
  - 1,713 sorties flown
  - 3,773 hours flown
  - 19 Radar Parts (WRAs) ordered
  - 137 Maintenance Discrepancies written against the radar

Radar Reliability Exceeded Predictions and Maintainers Complained of Nothing to DO

Results of VFA-213 Squadron Deployment

- Deployed on cruise with 12 F/A-18F aircraft
- Over 7.5 month deployment (September to April)
  - 2,120 Sorties flown
  - 6,536 Hours flown
  - 24 Radar Parts (WRAs) ordered
  - 245 Maintenance actions written against the radar

Lessons Learned - The Good

Raytheon

- Communications throughout the planning & deployment crucial
- Getting all the stakeholders involved early led to better planning and execution
- The work-around procedures eliminated the previously experienced pilot problems
- Had the right set of Support Equipment to perform majority of required maintenance actions
- Had sufficient spares on board
- Broken Non-Classified Hardware was quickly removed and sent back to Raytheon for repair
- Additional tools and consumables were useful
- Great support from 24 hour help desk
- Prior to deployment, the verification of spares, consumables and support equipment paid huge dividends while deployed!
  - Inventory discrepancies
  - Incorrect NIIN's
  - Wrong location
  - Missing quantities

Did it but could have been easier

Lessons Learned – The Not so Good

- Was very difficult and time consuming to perform pre-deployment verification of spares, consumables and support equipment
- Lacked ability to remove Integrated Radar Rack without improvising a stand and using extra bodies
- Process to get broken classified hardware off the ship and back to depot was inconsistent and slow.
- Didn't identify all the consumables that were needed.
  – Missing one cable

VFA-22 & VFA-213 and AESA

Raytheon

- First AESA squadrons to:
  - Complete the workup cycle
  - Fly Combat Missions
  - Drop ordnance in Combat
  - Fire the gun in Combat
  - Complete a successful CVN deployment
  - Numerous AESA articles written
    - Defense daily
    - Stars and Stripes
    - Sea Power Magazine

A Successful Deployment – Setting the Standard

Question and Answer

Air Force Institute of Technology

NDIA Systems Engineering Conference

System of Systems Challenges and Solutions: Case Study Insights

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System of Systems

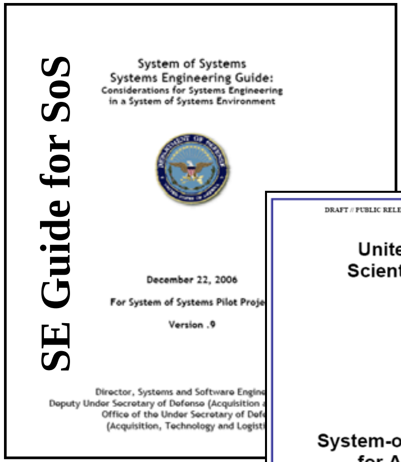
Cliché? Buzz word?

Any characteristics in an SoS different than a system?

Is the engineering effort in an SOS different than traditional Systems Engineering?

Welcome to the debate.

SE Guide for SoS


System of Systems
Systems Engineering Guide:
Considerations for Systems Engineering
in a System of Systems Environment

December 22, 2006

For System of Systems Pilot Proje

Version .9

Director, Systems and Software Engine
Deputy Under Secretary of Defense (Acquisition a
Office of the Under Secretary of Defe
(Acquisition, Technology and Logisti

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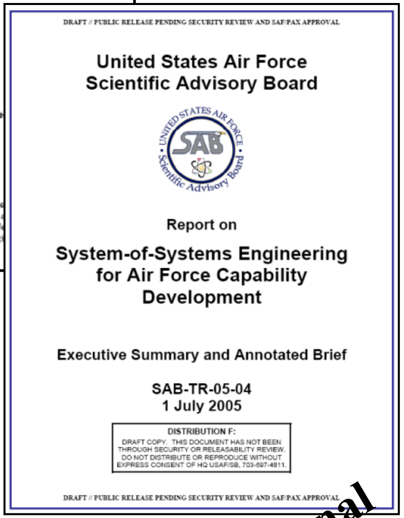
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United States Air Force
Scientific Advisory Board

Report on

System-of-Systems Engineering
for Air Force Capability
Development

Executive Summary and Annotated Brief

SAB-TR-05-04
1 July 2005

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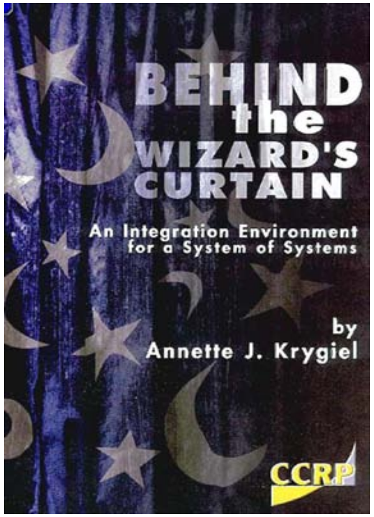


IEEE Systems Journal

SoS Eng Conferences

SoS Track at NDIA

Disclaimer/ Acknowledgements

The views expressed in this presentation are those of the authors and do not reflect the official policy or position of the Air Force Institute of Technology, the United States Air Force, the Department of Defense or the United States Government.

As a professor, I am obligated to put this disclaimer on everything

Thanks to the many interviewed (Gov't, FFRDC, SETA, primes) and to many students

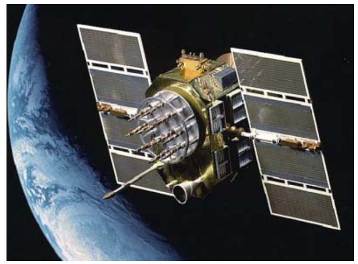
Major Katosic	Major Nance	Major Barker
Major Yates	Major Bode	Major Couluris
Major Ferko	Major Gunn	Major Sheesley
Major Cohee	Major Turner	

Agenda

- System-of-Systems Challenges
  - Definition
  - Characteristics
  - Challenges and Example Cases
- Implementation Strategies/ Solution Considerations
  - Engineering the SoS
  - Architecture and Patterns
  - Interface Management
  - Test and Evaluation
  - Agile Development
- Summary

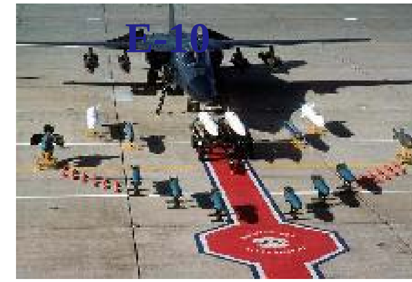
Systems Engineering Case Studies*

C-5 Galaxy



GPS

A-10

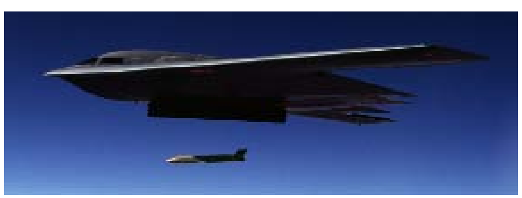


F-111

Hubble Space Telescope

JASSM

TBMCS (Theater Battle Management Core Systems)



B-2 Spirit

Peacekeeper

In work / In plan
-International Space Station
-Global Hawk
- KC-135 trainer
- T-6A, E-10
- MH-53J/M Helicopter

Classified cases

2007, 08, 09

*** Unclassified cases available for download http://www.afit.edu/cse**

SoS Definition

A SoS is defined as a set or arrangement of systems that results from independent systems integrated into a larger system that delivers unique capabilities.

-- Defense Acquisition Guide

- Maier (1998) highlights two characteristics that distinguish the SoS from very large complex monolithic systems:
  - 1. **Operational Independence**
  - 2. **Managerial Independence**

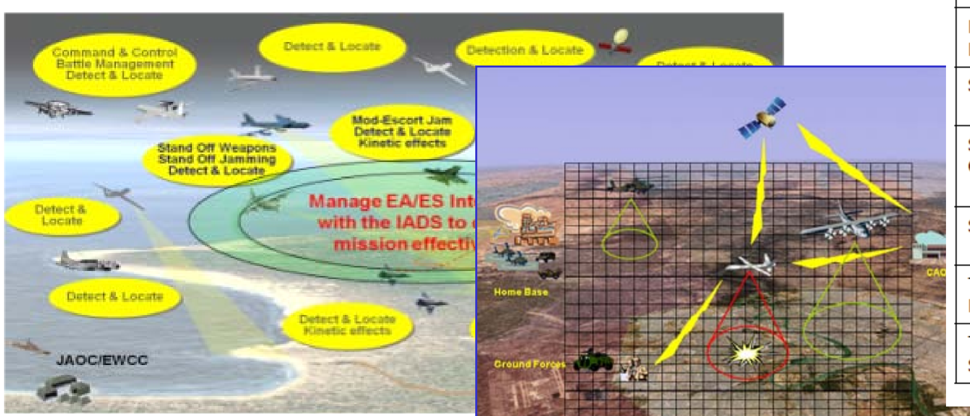
- Maier (1996) and others originally stated others characteristics
  - 3. **Evolutionary Development**.
  - 4. **Emergent Behavior:**
  - 5. **Geographic Distribution:**

Lots of DoD SoS Examples

- **Space Community**
  - **…"single, fully integrated, multi-INT architecture"**
  - **…"Community-wide architecture"   …"ground architecture"**
  - **…"overhead enterprise architecture"**
- **C4ISR Community**
  - **Small Clusters of Systems (U2 – Datalink – DCGS)**
  - **Air Force Constellation Net**
  - **Air Force Research Lab's Layered Sensing concept**
  - **Airborne Electronic Attack (AEA) SoS Architecture**

Name	Acronym	Owner
Army Battle Command System	ABCS	Army
Air Operations Center	AOC	Air Force
Ballistic Missile Defense System	BMDS	Joint
USCG Command & Control Convergence	C2 Convergence	Coast Guard
Common Aviation Command & Control System	CAC2S	Marine Corps
Distributed Common Ground Station	DCGS-AF	Air Force
DoD Intelligence Information System	DoDIIS	Intel
Future Combat Systems	FCS	Army
Ground Combat Systems	GCS	Army
Military Satellite Communications	MILSATCOM	Joint
Naval Integrated Fire Control – Counter Air	NIFC-CA	Navy

Name	Acro
Naval Surface Warfare Center Dahlgren Division	NSWC
Single Integrated Air Picture	SIAP
Space and Missile Systems Center	SMC
Space Radar	SR
Theater Joint Tactical Networks	TJTN
Theater Medical Information Systems – Joint	TMIP



*** From DoD SoS Engineering Guide v1.0**

SoS Challenges

Interface Management

SoS Performance

SoS capabilities

LEADERSHIP

Competing Operational Demands (LDHD)

INTEGRATION FUNDING

Schedules

Test and Evaluation

Complexity

Stakeholders

Requirements Management

Control

Boundaries

STANDARDS

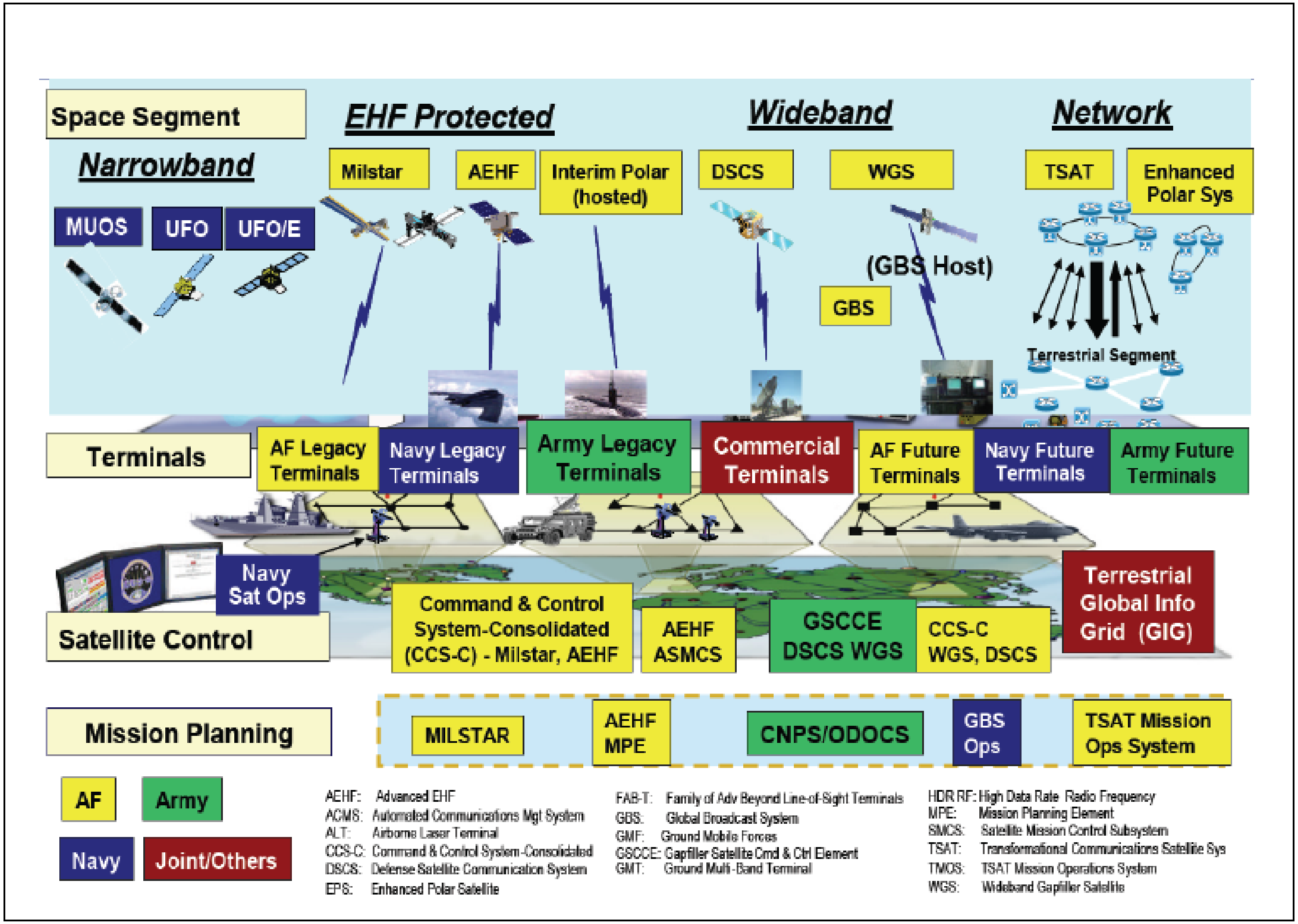
Interfaces

Legacy Issues

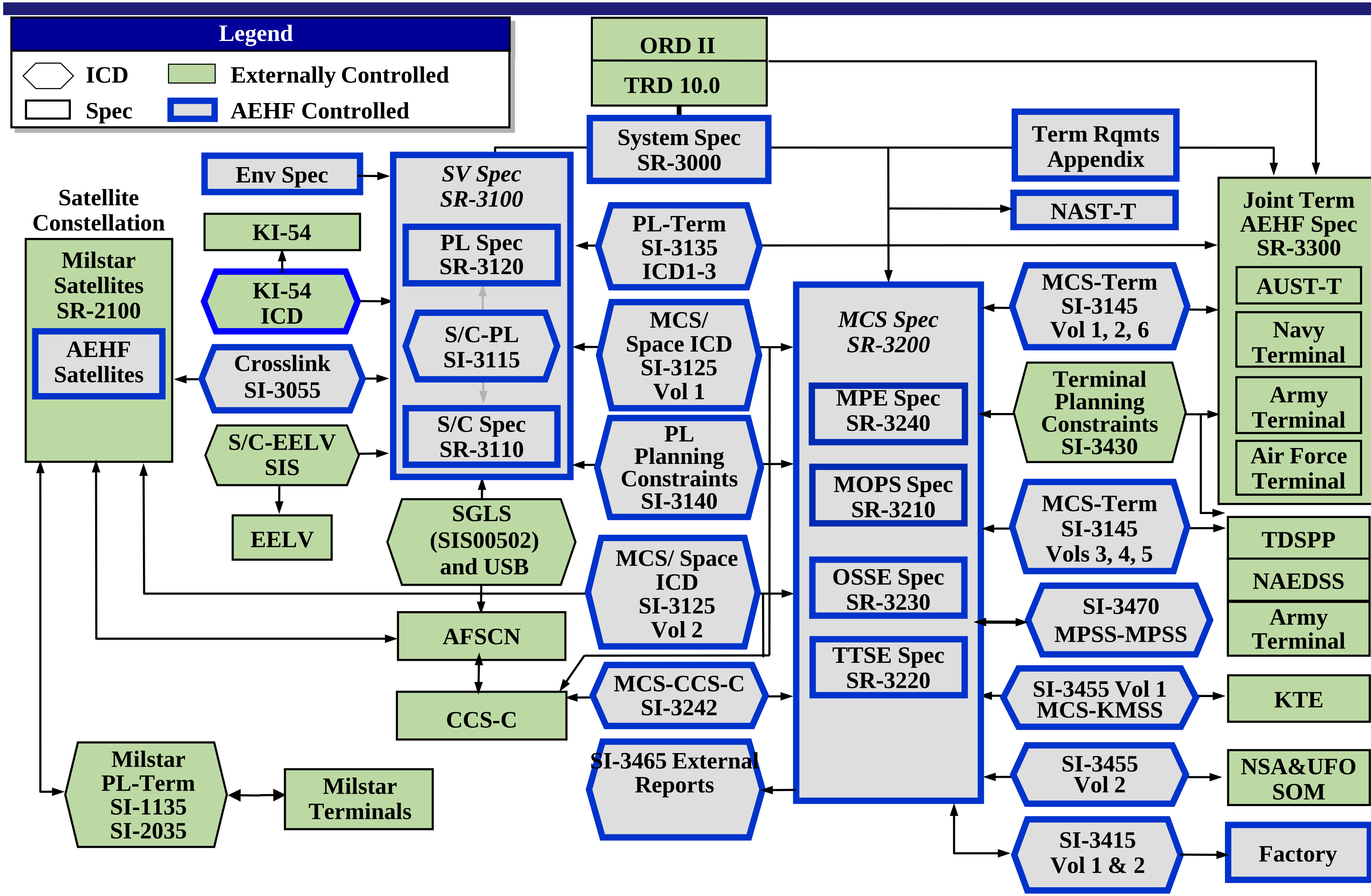
Survey Item	Percent
Leadership	75%
Requirements Communication	75
Standards	71
Funding	68
Knowledge Skills and Abilities	54
Aligning System Interdependencies	50
End to End Mission Threads	46
Configuration Management	39
Changing Environmental Demands	32
Information Access	32
Organizational Alignment	29
Commitment	25
Understanding Scope	25
Deconflicting Schedules	25
Doctrine	21
Interdisciplinary Teams	21
Conflict Negotiation	21

Let's focus on a few…

MILSATCOM (AEHF) Interface Management Case

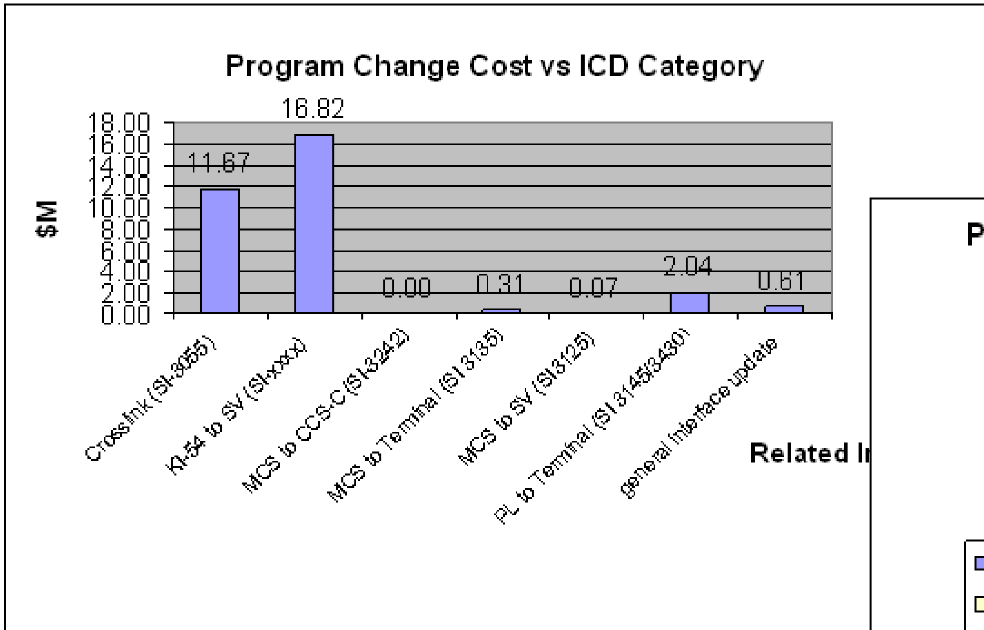


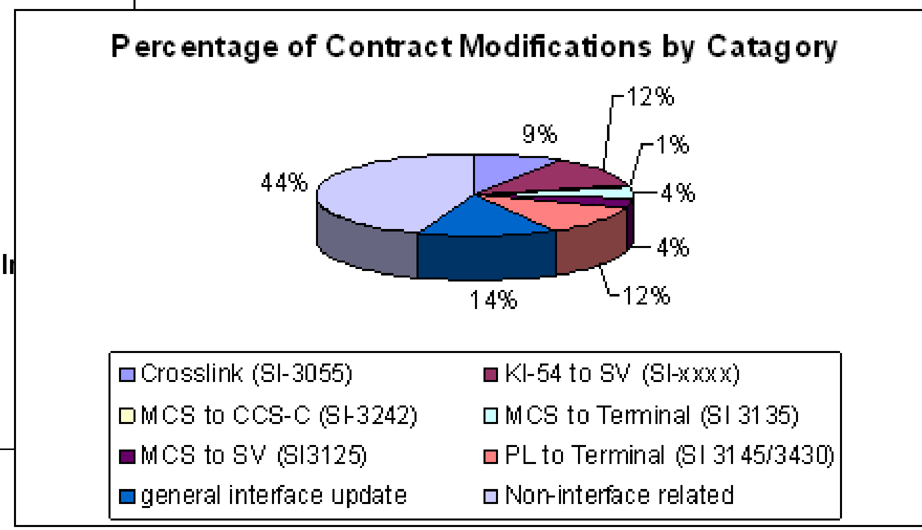
Interface landscape



Cost of Interface Management

In a 3 year period, 56% of baseline modifications were ICD-related
$31.5M of $71.2M (44%) of contract modifications were ICD-related

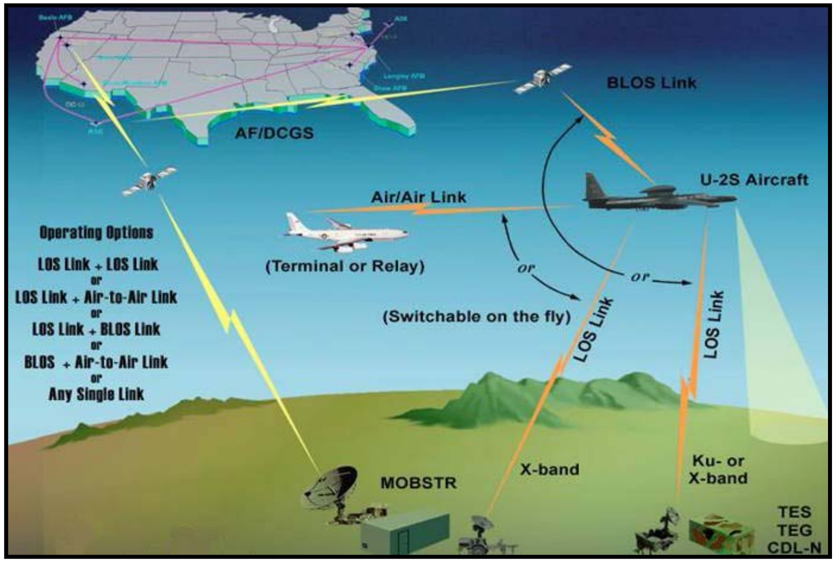




Case Observation

- **Cost and Effort of SoS Integration**

U-2 SoS T&E case



U-2S aircraft

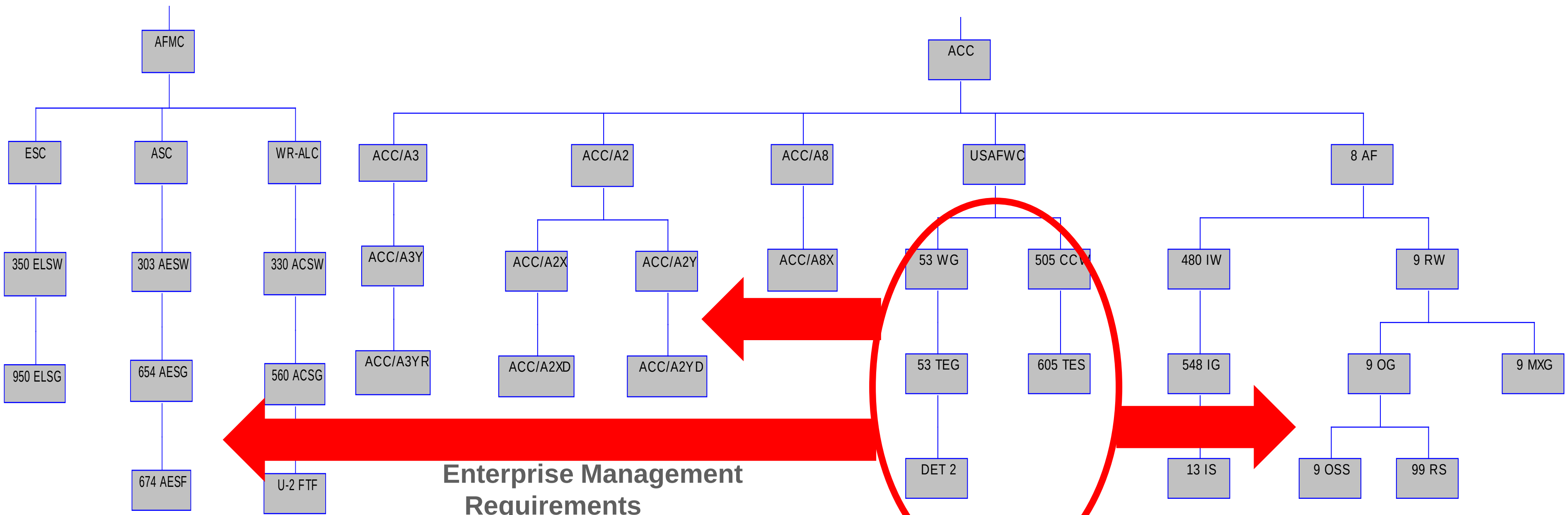
Upgraded SYERS-2A
--multispectral (EO/IR) sensor

Dual Data Link 2 (LOS/ BLOS)

Distributed Common Ground Station

- **Operational concern:**
  - **Test events being planned without full coordination**
  - **T&E plans not fully validated**
  - **Missing opportunities to “piggy-back” test objectives**
- **Examined Force Development Evaluation T&E Process**

U-2 SoS T&E case



Enterprise Management
Requirements
Test Resourcing
Test Coordination

Test Planning
Test Execution
Airborne and C2

Operations
Air and Ground

C2 Sustainment (O&M)
Aircraft Sustainment (O&M)
C2 System Program Management
New Acquisition and Modernization
Aircraft System Program Management
New Acquisition and Modernization
Flight Test Facility

Test Objective: "Verify new SYERS-2A sensor end-to-end operations and to demonstrate full airborne/ground segment functionality with DLL2 in available configurations and operational representative architectures"

SoS T&E case

- **Case Observations**
  - **SoS Integration is NOT Built Into the Process**
  - **“Seamless” Seams Among Interdependent Systems still Real**
  - **Ability to Define the “Ends” Disappearing**
  - **Program Priorities Dominate**

DoD T&E Summit, 2004, Dr. Glenn Lamartin

- *Increasing complexity and interdependencies of systems*
- *Exponential growth in interfaces (network participants)*
- *Increased requirements for T&E (Evolutionary Acquisition)*

Network Centric Warfare, 1996, Alberts, Garstka and Stein

“Testing systems will become far more complex since the focus will not be on the performance of individual systems by on the performance of the federation of systems”

SoS Emerging Solutions

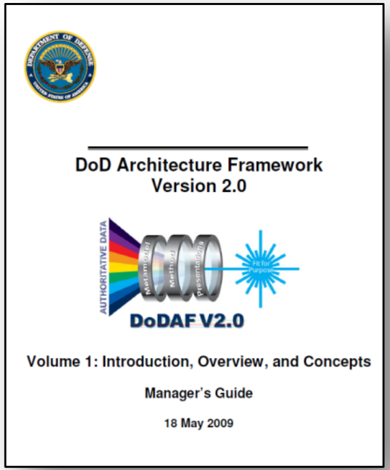
- Importance of Architecture across the SoS
  - Focus on interfaces
  - Architectural Pattern
- Acknowledging the different roles for SoS
  - SoS Integration and T&E Lessons Learned
  - Systems engineering versus SoS Engineering/ Architecting
- Address acquisition management issues
  - Agile development methodologies
  - Appropriate contracting strategies

AFIT

Solution - Architecture

Emphasize Operational, Systems Engineering

- Top-down Architecting and Architecture frameworks (DoDAF, Zachman, TOGAF, FEAF, etc)
- Bottom-up system integration for new
  CONOPS and Capabilities
- Early Architecture Evaluation/ Analysis
- Define, organize and communicate interfaces


DoD Architecture Framework
Version 2.0

DoDAF V2.0

Volume 1: Introduction, Overview, and Concepts

Manager's Guide

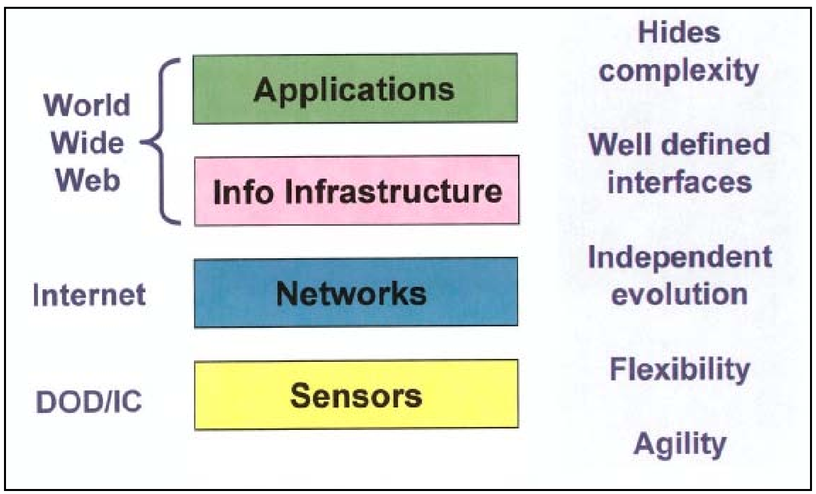
18 May 2009

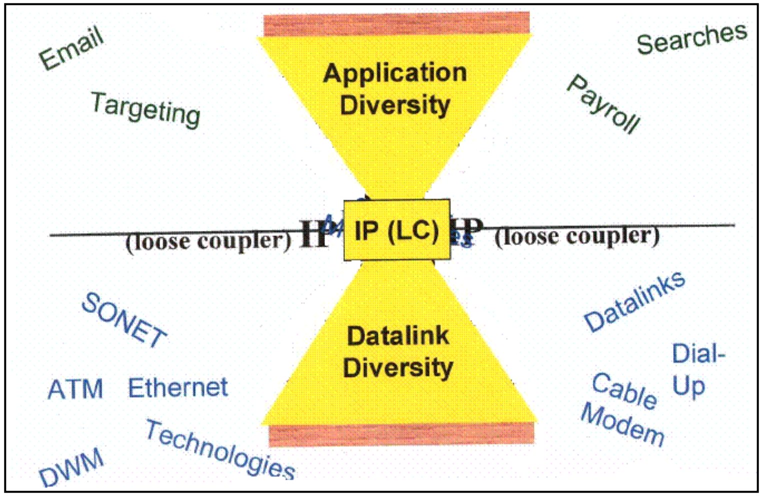
"The greatest leverage in system architecting is at the interfaces … the greatest dangers are also at the interfaces!"

— Mark W. Maier and Eberhardt Rechtin,
The Art of Systems Architecting, CRC Press, 2002

Solution-Architectural Patterns

- **Architect interfaces at all levels of abstraction for agility, adaptability (evolution) and growth**
  - **Layers and "Bowtie" architectural pattern for SoS agility***
  - **SAB concept of "convergence protocol"****

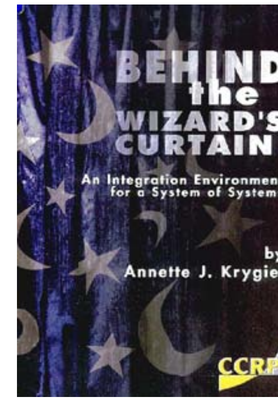


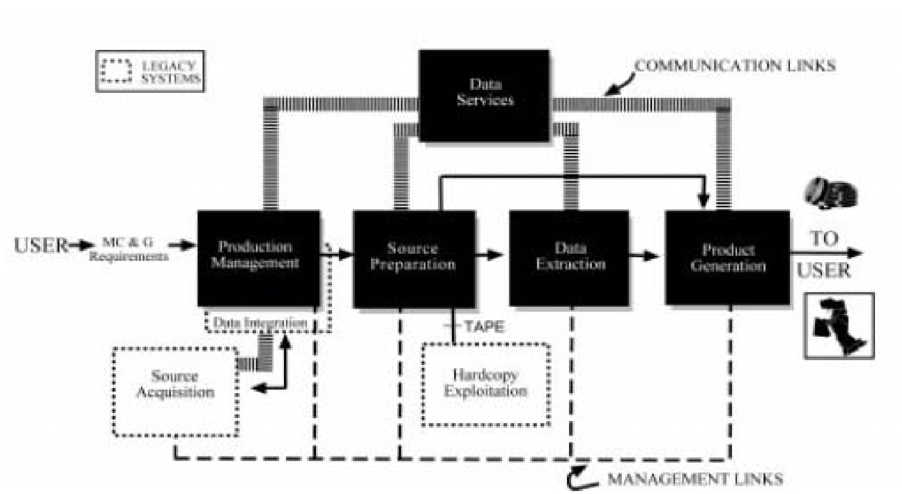


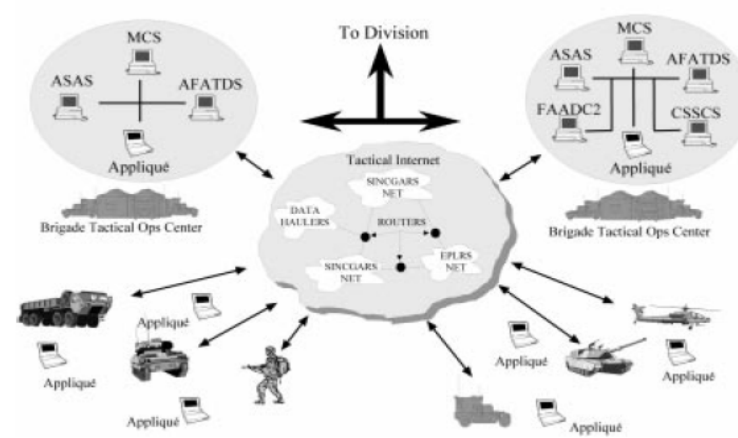
*** Rich Bryne, MITRE, from 2008 NRO Systems Engineering Conference**
**** Scientific Advisory Board 2004,**

Solution SoS Integration/ T&E

- Annette Krygiel's "Behind the Wizard's Curtain"
- SoS Integration (mid 1990s) for
  - Digital Mapping Agency
    - Digital production
  - Army Task Force XXI
    - Digital battlefield







Solution - SoS Integration/T&E

1. Key Activities need to preceed SoS integration
   - Architecture and architecture compliance, system test
2. Robust Testing strategy. Early, incremental and iterative integration
   - Build a little--test a little
3. Plan for substantial difficulties, significant time and resources
4. One site facilitates integration and test of SoS components
5. Address the leadership of the SoS integration
6. Prototyping the SoS provides early insight to ops requirements
   - Test with Operators

*Solution - Engineering for SoS**

1. <u>Translating SoS Capability</u> Objectives into High-Level SoS Requirements over Time
2. <u>Understanding the Constituent Systems</u> and Their Relationships over Time
3. Assessing Extent to Which <u>SoS Performance</u> Meets Capability Objectives over Time
4. Developing, Evolving and Maintaining an <u>Architecture for the SoS</u>
5. Monitoring and Assessing <u>Potential Risk and Opportunities</u> on SoS Performance
6. Addressing <u>SoS Requirements and Solution Options</u>
7. <u>Orchestrating Upgrades</u> to SoS

* From DoD SoS Engineering Guide v1.0

AFIT

Engineering an SoS
Two SoS extremes

"DIRECTED" SoS
(TO BE/ OBJECTIVE)

Ops Mission Architecture
+ Decompose Segments/ Systems

Lead Systems Integration (LSI)

Govt LSI

Prime (LSI w/ subs)
Design Control

LSI w/ multi Primes
(ACA) Coord/Plan/Architect

"ACKNOWLEDGED" SoS
(TO BE/ OBJECTIVE)

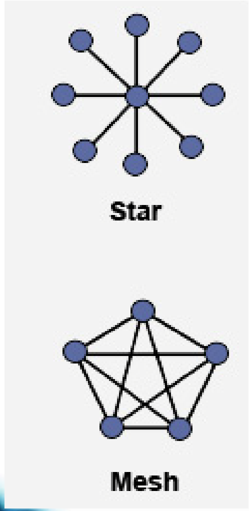
New Missions
+ New Capabilities

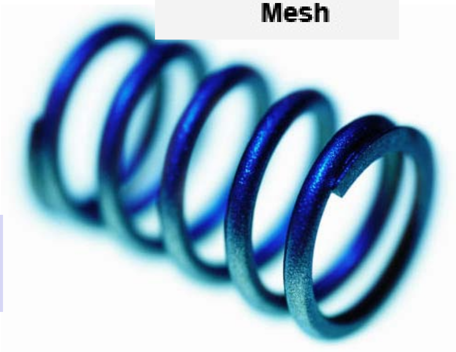
Modify + New Systems
+ Integration/ Design/ Architecture

Baseline Systems (AS IS)

Need for Agile/ Adaptability

- Changing Requirements across the SOS
  - Add/ Subtract/ Move (phasing)
  - Clarify/ Definition of Requirements based on Ops feedback
- Changing Schedule across the SOS
  - Move work requirements (phasing)
  - Deployment to sites/ Ops tempo
- Changing Interfaces
  - Add new interfaces, Changing/ Clarify Definition





One PM suggested the need for "Flexpoints"

Solution – Acq Implications

- **Organizational (People)**
  - **Experience with SoS Strategies**
  - **Experience with Agile development methodology**
  - **Familiarity (or connection) with the Domain (system type)**
  - **Attitudes – collaborative, communicative**

- **Development Method**
  - **Spiral or Iterative Lifecycle**
  - **Scrum software practices**
  - **Ability to handle CHANGE**

Conclusion

- SoS Lessons can be learned from system, enterprise and SoS case studies
- DoD policy and guidelines now reflect the changing IT landscape of system of systems
  - Leaders have predicted this changing landscape will directly impact engineering activities
- Requirements & Acquisition community must address
  - Growing program interdependencies
  - Greater numbers of potential changes across the SoS
  - The ability to operational test (and resource those tests)
  - Organization aspects to best handle SoS challenges

A Methodology for Assessing Systems Engineering Practices

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David McDonnell – David.McDonnell@jhuapl.edu
Timothy Herder – Tim.Herder@jhuapl.edu

Approved for public release; distribution is unlimited.
SMC Case no. 09-423

The Johns Hopkins University
APPLIED PHYSICS LABORATORY

Agenda

- Purpose for Devising a Systems Engineering Assessment Methodology
- Systems Engineering Assessment Methodology Overview
- Systems Engineering Case Study
- Systems Engineering Assessment Methodology – Potential Applications
- Summary

Purpose for Devising a Systems Engineering (SE) Assessment Methodology

- To assess the effectiveness of systems engineering activities and to show how this knowledge can assist with planning for activities on current and future programs.

SE Assessment Methodology Overview – Systems Engineering Method

- Logical set of activities to be accomplished in every System Life Cycle phase

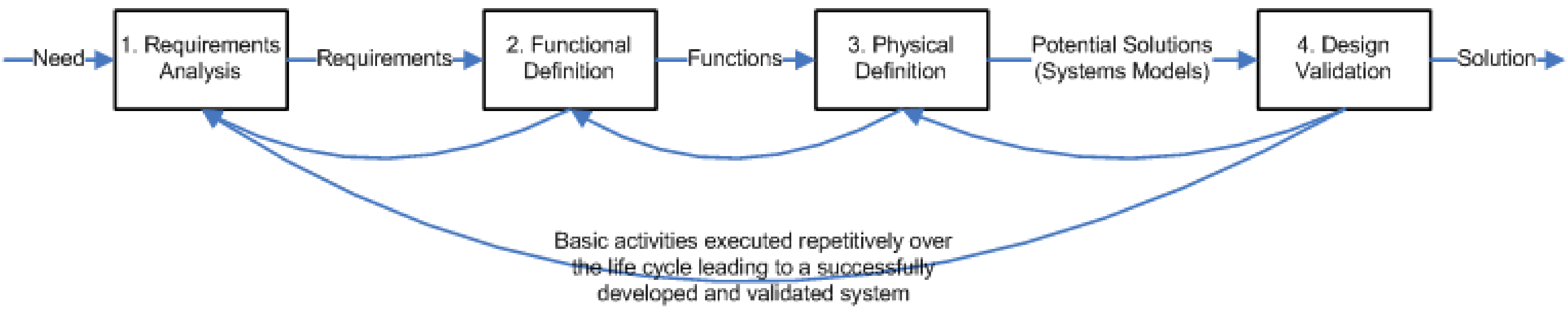

Figure adapted from “Systems Engineering Principles and Practice”, Kossiakoff and Sweet, 2003

Requirements Analysis – Assemble and organize input conditions and clarify, correct, and quantify what the system must do

Functional Definition – Translate requirements into functions and define interactions among functional elements

Physical Definition – Translate functional design into hardware and software components and select preferred approach to best balance performance, risk, cost, and schedule

Design Validation – Design models and the system test environment then simulates or test/analyze system with the models

SE Assessment Methodology Overview – System Life Cycle

- System Life Cycle: divides complex system development process into phases

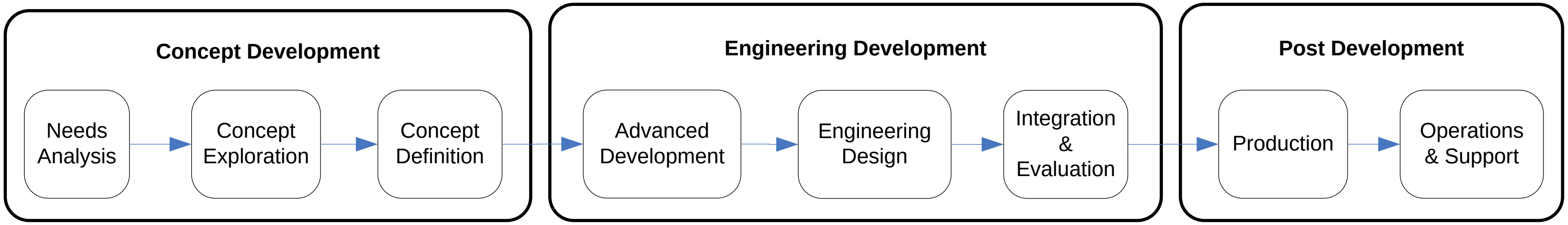

Figure adapted from "Systems Engineering Principles and Practice", Kossiakoff and Sweet, 2003

- **Needs Analysis** – Defines the need for a new system and determines if there is a practical approach to satisfying such a need
- **Concept Exploration** – Examines potential system concepts and identifies required performance and feasibility of possible approaches
- **Concept Definition** – Analyzes a number of alternative concepts in order to select a preferred concept that will be developed

SE Assessment Methodology Overview – Phase Sequence

- The Systems Engineering Method is applied iteratively to each phase of the System Life Cycle
  - This example shows the Concept Development phase:

Systems Engineering Method Step	Concept Development Life Cycle Phase		
	Needs Analysis	**Concept Exploration**	**Concept Definition**
Requirements Analysis	A: Analyze needs	E: Analyze operational requirements	I: Analyze performance requirements
Functional Definition	B: Define system functions	F: Define subsystem functions	J: Define component functions
Physical Definition	C: Visualize subsystem technology	G: Visualize components, architectures	K: Select components, architecture
Design Validation	D: Validate needs, feasibility	H: Validate performance requirements	L: Simulate, validate system effectiveness

Figure adapted from “Systems Engineering Principles and Practice,” Kossiakoff and Sweet, 2003

SE Assessment Methodology Overview – Activity Context

- Need knowledge from the prior steps for current step
  - May be done by same people/organization or others
  - Accumulated steps provide the whole picture
- Information does not need to be complete to start next activity steps
  - Should be sufficient level to support <u>initiating</u> the next activities

SE Assessment Methodology Overview – Terminology

- Impact refers to the level of influence on the program
  - Impact ≠ Effort : Impact does not necessarily reflect amount of effort by contractor and program office
- Assessed impact to the project/program
  - Three levels of impact (High, Medium, and Low) as determined by Sponsor and Subject Matter Experts
- “Actual” vs. “Ideal” Impact
  - “Ideal” impact assumes prior steps were done sufficiently to support informational needs for this step and effort progresses exactly as originally planned
    - “Ideal” varies depending on intended application of SE Method
  - “Actual” impact is the assessed program impact of the systems engineering effort

Systems Engineering Case Study – Assessment Goals

- Understand the impact of APL SE actions and activities on the program and their relationship to the whole
  - Devise a way to look back at how tasking evolved from baseline plan and its impact on the effectiveness of the program
  - Conduct assessment of activities to understand why unanticipated activities occurred
  - Provide considerations and guidance to be used for planning and organizing future activities

Systems Engineering Case Study – Case Study Description

- Sponsor: Air Force Space Command - Space and Missile Systems Center (SMC)
- Initial Tasking
  - Systems Engineering - Requirements generation and integration of pilot program
  - Intended scope - Concept Exploration Phase within Concept Development
- Evolution: as tasks progressed, information gaps were identified and activities shifted (with sponsor concurrence) to address these needs
  - Evolution within a program is anticipated, to a certain extent, with the discovery and realization of key system concepts
  - In this case study, tasking and activity changes differed from what was expected with standard SE program evolution
  - It is important to understand why unanticipated activities occur to help learn and improve for the future

Systems Engineering Case Study – Major Activities

- Requirements Generation
  - Requirements Definition
  - Mission Analysis
  - Technology and User Studies
  - Modeling
- Prototyping
  - Concept Demonstrator
  - Concept Development Testing Environment

Systems Engineering Case Study – Requirements Definition: Ideal

Systems Engineering Method Step	Concept Development Life Cycle Phase		
	Needs Analysis	Concept Exploration	Concept Definition
Requirements Analysis	A	E	I
Functional Definition	B	F	J
Physical Definition	C	G	K
Design Validation	D	H	L
Key:	High Impact	Medium Impact	Low Impact

- Anticipated requirements activity: create a Technical Requirements Document

Systems Engineering Case Study – Requirements Definition: Actual

Systems Engineering Method Step	Concept Development Life Cycle Phase		
	Needs Analysis	Concept Exploration	Concept Definition
Requirements Analysis	A	E	I
Functional Definition	B	F	J
Physical Definition	C	G	K
Design Validation	D	H	L
Key:	High Impact	Medium Impact	Low Impact

- Tasked to develop Technical Requirements Document (TRD)
  - Found guidance documents lacked needed detail
  - Added Process Flow documents to supplement Needs Analysis information and provide common understanding of system functions

Systems Engineering Case Study – Requirements Definition: Comparison

Ideal	Concept Development Life Cycle Phase		
	Needs Analysis	Concept Exploration	Concept Definition
Requirements Analysis	A	E	I
Functional Definition	B	F	J
Physical Definition	C	G	K
Design Validation	D	H	L
Key:	High Impact	Medium Impact	Low Impact

Actual	Concept Development Life Cycle Phase		
	Needs Analysis	Concept Exploration	Concept Definition
Requirements Analysis	A	E	I
Functional Definition	B	F	J
Physical Definition	C	G	K
Design Validation	D	H	L
Key:	High Impact	Medium Impact	Low Impact

- Early Needs Analysis information was not mature
  - Shift in focus needed to earlier steps
  - Resources and information unavailable to properly address later steps
- Level of resulting information insufficient to support follow-on Concept Definition activities

Systems Engineering Case Study – Mission Analysis: Ideal

Systems Engineering Method Step	Concept Development Life Cycle Phase		
	Needs Analysis	Concept Exploration	Concept Definition
Requirements Analysis	A	E	I
Functional Definition	B	F	J
Physical Definition	C	G	K
Design Validation	D	H	L
Key:	High Impact	Medium Impact	Low Impact

- Analyses conducted to support requirements effort

Systems Engineering Case Study – Mission Analysis: Actual

Systems Engineering Method Step	Concept Development Life Cycle Phase		
	Needs Analysis	Concept Exploration	Concept Definition
Requirements Analysis	A	E	I
Functional Definition	B	F	J
Physical Definition	C	G	K
Design Validation	D	H	L
Key:	High Impact	Medium Impact	Low Impact

- Provided important knowledge to support requirements activities
- Helped to supplement incomplete Needs Analysis information

Systems Engineering Case Study – Mission Analysis: Comparison

Ideal	Concept Development Life Cycle Phase		
	Needs Analysis	Concept Exploration	Concept Definition
Requirements Analysis	A	E	I
Functional Definition	B	F	J
Physical Definition	C	G	K
Design Validation	D	H	L
Key:	High Impact	Medium Impact	Low Impact

Actual	Concept Development Life Cycle Phase		
	Needs Analysis	Concept Exploration	Concept Definition
Requirements Analysis	A	E	I
Functional Definition	B	F	J
Physical Definition	C	G	K
Design Validation	D	H	L
Key:	High Impact	Medium Impact	Low Impact

- Actual impact in Concept Exploration was relatively close the ideal impact
- Mission needs were unclear, thus analysis had to address earlier steps in Needs Analysis than initially intended
  - Resulted in diminished ability to address Physical Definition and Design Validation steps

Systems Engineering Case Study – Summary Tables

Ideal Summary

LC Phase	1 Needs Analysis				2 Concept Exploration				3 Concept Definition			
SE Step	1 RA	2 FD	3 PD	4 DV	1 RA	2 FD	3 PD	4 DV	1 RA	2 FD	3 PD	4 DV
Cell	A	B	C	D	E	F	G	H	I	J	K	L
Requirements					H	H	H	L	M	M		
Mission Analysis			M	H	H	H	M	L				
Tech /User Studies					M	M	H	L	L	M		
Modeling				L	L	L	M	H	H	M		
Concept Demo					L	M	M	H		L	L	M
Concept Testing			L	L			H	H			M	M

Actual Summary

LC Phase	1 Needs Analysis				2 Concept Exploration				3 Concept Definition			
SE Step	1 RA	2 FD	3 PD	4 DV	1 RA	2 FD	3 PD	4 DV	1 RA	2 FD	3 PD	4 DV
Cell	A	B	C	D	E	F	G	H	I	J	K	L
Requirements	M	H			H	H			L			
Mission Analysis	H	M		L	H	H	L	L				
Tech/User Studies	M	L	L	L	M							
Modeling						L	M	L				
Concept Demo					L	M	M	L		L		
Concept Testing						L	L	M				

Systems Engineering Case Study – Summary Assessment

- Relative to Ideal impact, Actual impact overall was
  - Less than anticipated
    - Especially in Physical Definition and Design Validation steps
  - Earlier in the life cycle than anticipated
    - Provided higher impact in Needs Analysis
    - Identified some needed information
    - Uncovered additional questions to be addressed by sponsor organizations

- Impact to Concept Exploration and Concept Definition phases was lessened due to Needs Analysis phase deficiencies
  - Information was insufficient to support CE and CD activities
  - Efforts diverted to the Needs Analysis phase

Systems Engineering Assessment Methodology – Potential Applications

- Program Office planning and tasking
  - Help to identify information needs and potential gaps
  - Help to visualize activities and what makes them successful
    - Map each activity to appropriate step(s) and identify information that precedes it as well as what steps it supports in turn
- Coordination of efforts
  - Can be a common means of coordination between organizations
  - Set expectations for inputs and outputs for task activities
    - Clarify deliverables impact and stakeholders

Summary

- This Methodology was useful to visualize the effectiveness of real-world systems engineering activities.
- Expect this Methodology to be useful in assessing the effectiveness of other programs so that additional lessons can be learned towards future improvements.
- Anticipate this Methodology may provide additional insight to sponsors and to internal SE teams in assessing what is required to support a given effort.

The Role of DoD in Systems Engineering Standards and Models

Donald J. Gantzer
Systems Engineering Directorate
Office of the Director, Defense Research and Engineering
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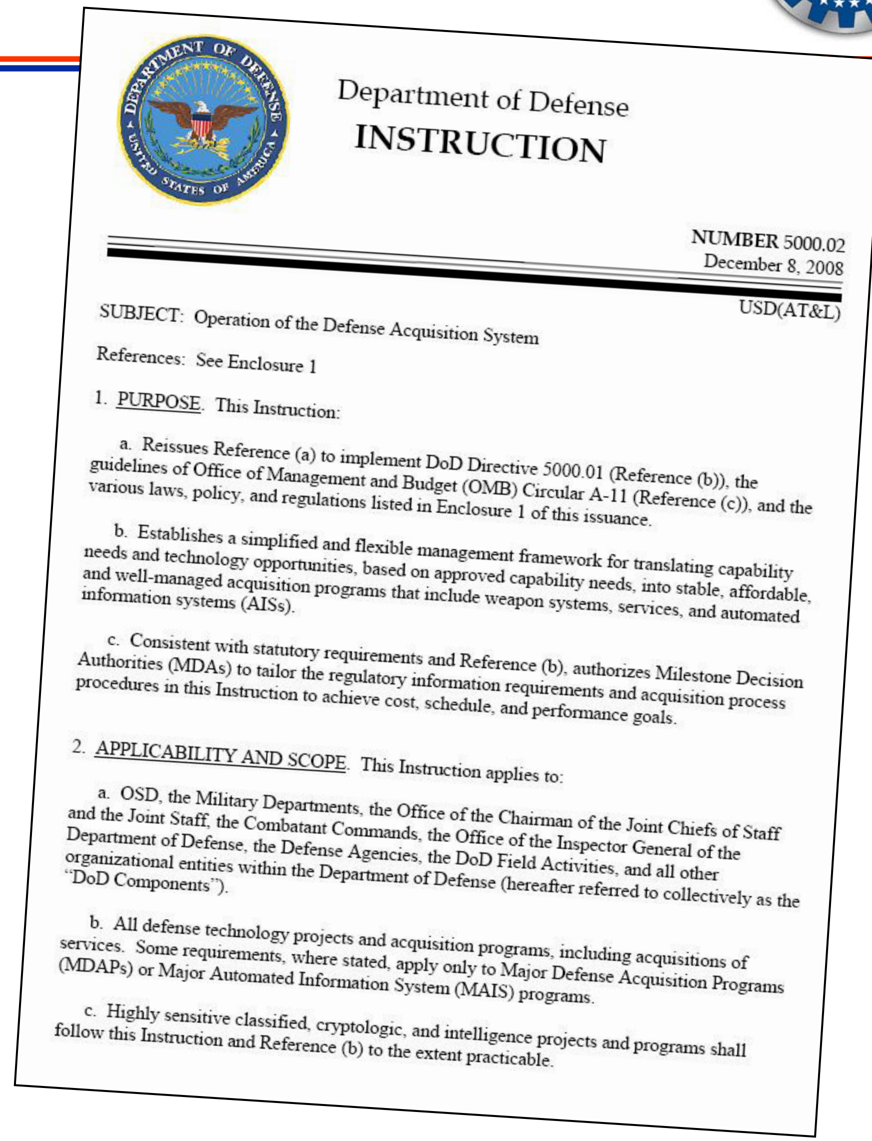
12th Annual NDIA Systems Engineering Conference
October 29, 2009

Outline

- New SE Policy and Legislation Implications
- SE Reorganization
- Defense Standards role
- SE standards activities

DoD Instruction 5000.02

- **Mandatory Materiel Development Decision**
- **Mandatory Milestone A for all "major weapon systems" requiring technology development**
- **Mandatory system-level PDR and CDR with reports to and assessments by the Milestone Decision Authority (MDA)**
- **Strengthened MDA certifications at Milestones A and B**



Department of Defense
INSTRUCTION

NUMBER 5000.02
December 8, 2008

USD(AT&L)

SUBJECT: Operation of the Defense Acquisition System

References: See Enclosure 1

1. PURPOSE. This Instruction:

a. Reissues Reference (a) to implement DoD Directive 5000.01 (Reference (b)), the guidelines of Office of Management and Budget (OMB) Circular A-11 (Reference (c)), and the various laws, policy, and regulations listed in Enclosure 1 of this issuance.

b. Establishes a simplified and flexible management framework for translating capability needs and technology opportunities, based on approved capability needs, into stable, affordable, and well-managed acquisition programs that include weapon systems, services, and automated information systems (AISs).

c. Consistent with statutory requirements and Reference (b), authorizes Milestone Decision Authorities (MDAs) to tailor the regulatory information requirements and acquisition process procedures in this Instruction to achieve cost, schedule, and performance goals.

2. APPLICABILITY AND SCOPE. This Instruction applies to:

a. OSD, the Military Departments, the Office of the Chairman of the Joint Chiefs of Staff and the Joint Staff, the Combatant Commands, the Office of the Inspector General of the Department of Defense, the Defense Agencies, the DoD Field Activities, and all other organizational entities within the Department of Defense (hereafter referred to collectively as the "DoD Components").

b. All defense technology projects and acquisition programs, including acquisitions of services. Some requirements, where stated, apply only to Major Defense Acquisition Programs (MDAPs) or Major Automated Information System (MAIS) programs.

c. Highly sensitive classified, cryptologic, and intelligence projects and programs shall follow this Instruction and Reference (b) to the extent practicable.

Summary of Legislation

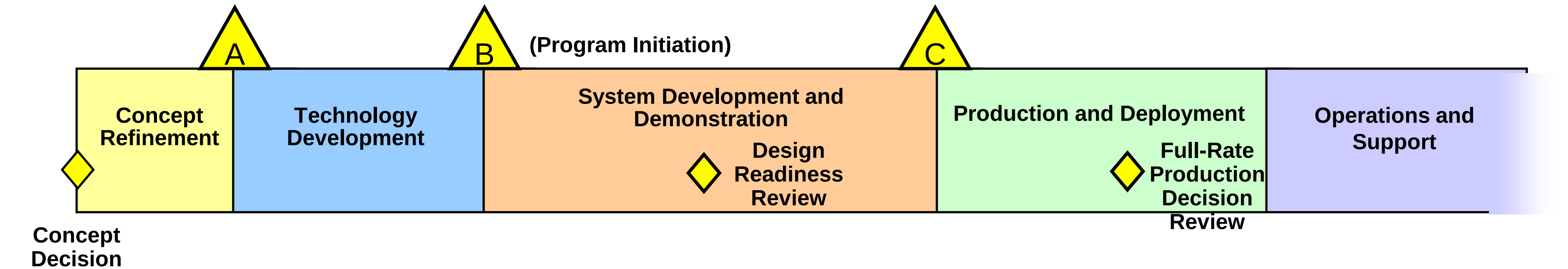
The Weapon Systems Acquisition Reform Act of 2009 contains provisions that will:

- Address problems with unreasonable performance requirements by requiring DoD to reestablish systems engineering organizations and developmental testing capabilities; make trade-offs between cost, schedule and performance early in the program cycle; and conduct preliminary design reviews before giving approval to new acquisition programs;
- Address problems with unreasonable cost and schedule estimates by establishing a new, independent director of cost assessment to ensure that unbiased data is available for senior DoD managers;
- Address problems with the use of immature technologies by requiring the Director of Defense Research and Engineering to periodically review and assess the maturity of critical technologies and by directing the Department to make greater use of prototypes, including competitive prototypes, to prove that new technologies work before trying to produce them; and
- Address problems with costly changes in the middle of a program by tightening the so-called “Nunn-McCurdy” requirements for underperforming programs.

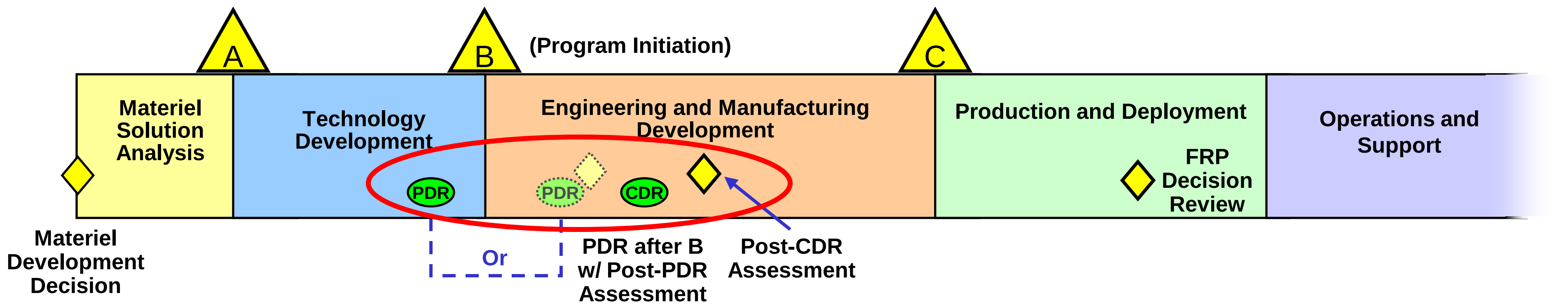
Excerpts from Bill Signing Ceremony Press Release – May 22, 2009

Acquisition Lifecycle Comparisons

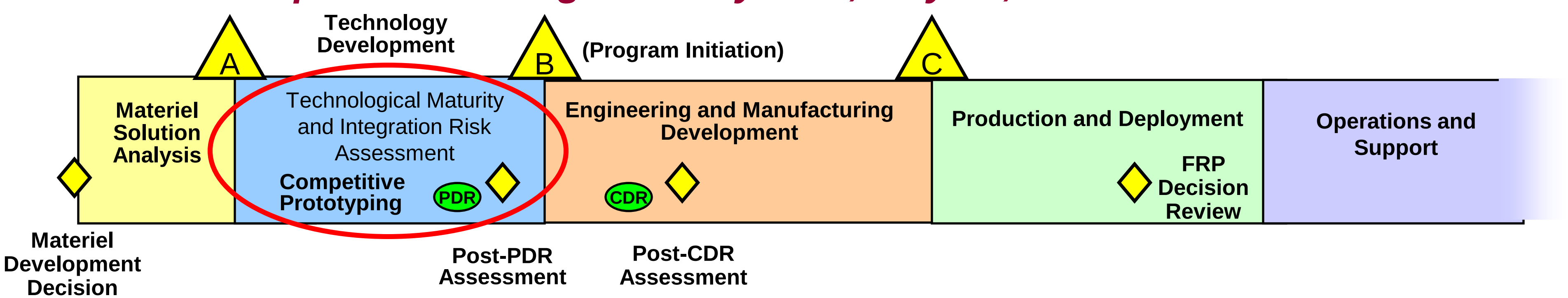
Defense Acquisition Management System, May 12, 2003



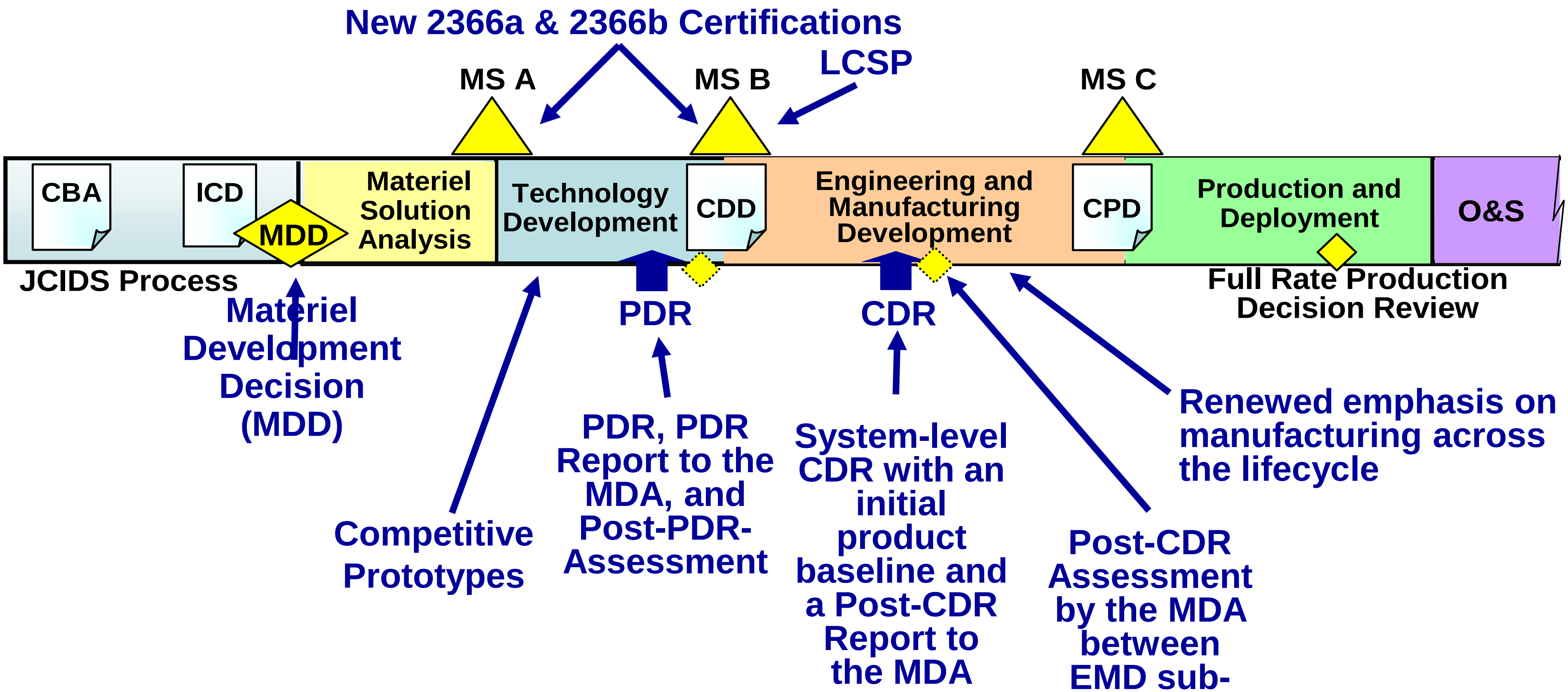
Defense Acquisition Management System, December 8, 2008



Defense Acquisition Management System, May 22, 2009



DoD 5000.02 and PL 111-23 Change the Early Acquisition Landscape



What are the implications of these changes for programs and SEs?
How can systems engineering enable the program during this early phase?
How can standards, handbooks/guides assist the programs?

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What This Means for Systems Engineers

- **Systems engineering is now recognized in law as inherently necessary in requirements definition, development planning, and early acquisition**
- **Need for and focus of *all* engineering in the "pre-acquisition" phases (Materiel Decision Analysis and Technology Development) is dramatically altered:**
  - **Earlier engineering involvement (well before Milestone A)**
  - **More government expertise to plan for and oversee requirements definition, technology maturation, and competitive prototyping leading to fully expressed system design (the allocated baseline) at the system-level Preliminary Design Review**

New Challenges for Programs

- Need for Program Office formation and PM skill-sets after MDD and prior to MS A
- Increased importance of the Technology Development Strategy (TDS) (as a surrogate Acquisition Strategy) at MS A
- Schedule and funding shifts – EMD into TD
- Earlier engagement with industry and different contracting strategies for technology maturation, competitive prototyping, data rights, PDR before MS B, etc.
- Explicit need for earlier, formal SE process application (e.g., data, configuration, and risk management)

DDR&E Organization

Director, Defense Research and Engineering (DDR&E)
Honorable Zachary J. Lemnios

Principal Deputy
Mr. Alan R. Shaffer

Defense Advanced Research Projects Agency (DARPA)
Dr. Regina Dugan

Defense Technical Information Center (DTIC)
Mr. Paul Ryan

Director, Research
Dr. David Honey
Principal Deputy
Dr. André van Tilborg

Director, Systems Engineering
Mr. Stephen Welby
Principal Deputy
Mr. Terry Jaggers

Director, Rapid Fielding
Mr. Earl Wyatt
Principal Deputy
Mr. Ben Riley

Director, Developmental Test & Evaluation (DT&E)
Mr. Chris DiPetto (Acting)
Principal Deputy
Mr. Chris DiPetto

Director, Systems Engineering (DDR&E SE)

Director, Systems Engineering Steve Welby

Principal Deputy Terry J. Jaggers

System Analysis

- Red teaming
- System trades
- System complexity analysis
- Modeling & Simulation Coordination Office
- Developmental planning
- System of Systems SE
- Program Protection Plan Policy & Guidance/Acquisition Cyber Security
- SE Research Center

Major Program Support

- Program Support Reviews
- System Engineering Plans
- Program Auditing functions
- OIPT/DAB/DSAB Support
- DAES Database Analysis and Support
- Measurements and Analysis
- T&E Oversight List

Mission Assurance

- **SE and SW Policy and Guidance**
- Specialty Engineering
- ***DoD Standardization Program Office****
- Workforce Development
- Mission Assurance Assessment
- Acquisition Reform Planning and Reporting for SE

Responsible to provide technical support, systems engineering (SE) oversight, program development and mission assurance certification to USD(AT&L) in support of planned and ongoing acquisition programs

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DOD Standardization Executive Realignment

- **Transfer from OSD Logistics to OSD Systems Engineering**
- **Why? - Weapon Systems Acquisition Reform Act of 2009 codifies Director of Systems Engineering**
  - Provide systems engineering principles & best practices to enhance reliability, availability, & maintainability of defense systems
    - Specifications & standards are key systems engineering process inputs to define requirements
    - Specifications & standards are key systems engineering process outputs to establish product baselines and measure compliance
- **Benefits of transfer – Director, Systems Engineering will set DoD-wide strategic direction for standards**
  - Standards are a key foundation of systems engineering
  - Standards reduce risk and cost in programs
  - Standards document & communicate lessons learned, interoperability, and technologies across entire sectors to form a common understanding

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Defense Standardization Program

Standardization Policy:*

DoD policy is to promote standardization of materiel, facilities, and engineering practices to improve military operational readiness, and reduce total ownership costs and acquisition cycle time. It is also DoD policy to state requirements in performance terms, wherever practical, and to make maximum use of non-Government standards and commercial technologies, products, and practices. To pursue these policies, there is a single, integrated Defense Standardization Program and a uniform series of specifications, standards, and related documents.

*Find out more by selecting the Policy link on the DSP web site: http://www.dsp.dla.mil/

ASSIST- Online: Acquisition Streamlining and Standardization Information System

- **Provides access to current information associated with military and federal handbooks, specifications and standards in the management of the Defense Standardization Program**
- **Includes reporting features and an exhaustive collection of both digital and warehoused documents**
- **Is the official source of DoD specifications and standards**
- **Includes international and US commercial standards and guides as deemed applicable by the DoD community**

Register at http://assist.daps.dla.mil/online/start/

SE Standards Revitalization

Background:

SE is DoD gatekeeper/manager for SE [and integration with SW Engineering] standards, specifications, and non-DoD guides in the ASSIST data base and a participant in international and national standards organizations for development, revision, coordination, and adoption of these documents

[Note: a large category of IT items in another functional area not addressed here]

Objective:

Update and maintain the SE and SWE portions of ASSIST; support efficient adoption of new and revised documents

Plan:

Define SE role in SE and SW standards; develop and publish processes for standards activities (development, revision, coordination, adoption, posting in ASSIST)

SE's Role in SE Standards*

- **Gatekeeper for Functional category /area: SE Standards and Specifications (SESS)**
  - ~360 active documents in SESS
  - 20+ involve SE participation as 'preparing agency'
- **National and International SE related Standards:**
  - Participate in standards bodies, as appropriate, to develop/revise
  - Coordinate review of new drafts/revisions to support DoD vote
  - Coordinate for adoption within DoD and placement in ASSIST
- **DoD Standards [related to SE]:**
  - Participate, as appropriate, in development/revision of DoD documents
  - Coordinate DoD drafts for acceptance and ASSIST placement
  - Coordinate Component-nominated documents for acceptance as a DoD spec/standard in ASSIST

also includes Specifications, Handbooks, DIDs

SESS Lead Standards Authority [LSA] Responsibilities

- Approves project #s from services requesting to adopt, update, develop new, or cancel standards / DIDs / handbooks / specs
- Coordinates review of such and mitigates issues
- Selects other documents to adopt, update, develop, etc.
- Ensures appropriate persons are involved
- Determines if certain items belong in SESS or elsewhere

List of Key SE Standards Bodies

- **ISO/IEC – International Standards Organization/ International Electrotechnical Commission [particularly the Systems & SW Engineering committee]**
- **TechAmerica – new [merger of GEIA, ITAA, +…]**
  - WGs of particular interest to DOD/SE are SE, CM/DM, Logistics, Safety, HIS, Enterprise Information Management & Interoperability [new]
- **IEEE – Institute of Electronics and Electrical Engineers**
- **ANSI – American National Standards Institute (a US standards accrediting agency and a source to purchase ISO/IEC standards); discounts**
- **NATO**
- **Others [e.g., AIA, AIAA, INCOSE]**

SE Policy & Guidance Recent Activities

- **Adopted ISO/IEC Standards into ASSIST**
  - 15288 [SE], 12207 [SWE, in progress], 16085 [Risk], 15939 [Measurement], 26702 [IEEE 1220:2005]
- **Reviewed ISO drafts** [in JTC1/SC7 for Systems & Software Engineering]
  - 24748-1,2,3 guide for Life cycle management and guides to 15288, 12207
  - 29148 [Requirements engineering],
  - 15026-parts 1-4 System & SW assurance
  - 10303 STEP – Standard for exchange of product, in process
- **GEIA/EIA [TechAmerica] activity**
  - EIA-649 STD and HDBK [CM] revision in draft
  - GEIA-Std-927 [A Common Data Schema for Complex Systems] in draft
  - GEIA-Std-0009 [Reliability Program Standard for System Design & Manufacturing; adopted]
  - GEIA-Std-0007 [Logistics Product Data]; handbook to follow
  - Mil-Std-973 [CM - although cancelled - now points to EIA-649]
  - GEIA-859 [DM; adopted]
- **Under development in SESS*** [DDRE/SE approves]
  - MIL-STD-189A Reliability Growth Management
  - Mil-Std-31000D Technical Data Package
  - Mil-Hdbk-? Acquisition Data Management – in revision
  - SEMP DiD updated

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OSD Participation in U.S. Technical Advisory Group (TAG)

- **TAG to International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) Subcommittee 7, *Software and Systems Engineering*, Working Group 7 (WG7), *Life Cycle Management***
  - Sharon Vannucci, OSD/SE Primary rep
  - Eddie Bauer, Army, DoD alternate representative
  - Karen Richter, Institute for Defense Analyses primary representative
- **Participation in standards meetings**
  - Two U.S. TAG meetings: Portland in April 2009 and Pittsburgh in August 2009
  - As part of U.S. national body delegation to WG7 Interim meeting in Nanning, China in Nov 2008
  - ISO/IEC 15026 Editors meeting in Osaka, Japan in August 2009
  - Next WG7 Interim Meeting in Peru in November 2009
- **Nomination by the U. S. National body as co-editors**
  - Karen Richter of all 4 parts of ISO/IEC 15026
  - Eddie Bauer for all 3 parts of ISO/IEC 24748

SE Policy and Guidance Structure

** Note: Currently Guides are not posted in ASSIST*

DoD 5000.02

Defense Acq Guidebook

Chapter 4 SE	**Chapter 8 Security**

Data Flow:

Acquisition Policy

Policy-specific guidance linked to . . .

. . . all other relevant guidance

M&S Guidance

DoD M&S Mgt DoDD 5000.59

DoD M&S VV&A DoDI 5000.61

RAM Guide

RAM-C Rationale Report Manual

CM Mil Hbk 61A

WBS Mil Hbk 881

Other Standards & Mil Handbooks

Risk Mgmt Guide

SE Slide Rule

Safety/ESOH Guides

Safety MIL-STD-882D

Contracting for SE Guide

SOS SE Guide

IMP/IMS Guide

MOSA Guide

Other Design Consideration Guides

"Wall Chart"

SEP Prep Guide

DM Guide

Functional Architecture Development Guide

Tech Review Guide

Planned

Extent

PPP DoDI 5200.39

Systems Assurance Guide

DTM 08-048 Supply Chain Risk Management

PPP Prep Guide

CPI Security Classification Guide

CPI Identification Tool

PP Contract Language Compendium

EW and C2W Countermeasures DoDD 3222.3

DoD IA DoDD 8500.01E

Interoperability & Supportability of IT & NSS DoDD 4630.05

Acq Security-Related Policies & Issuances Tool

http://www.acq.osd.mil/sse/pg/guidance.html

Systems Engineering Policy, Guidance and Standards - - Initial Focus Plan of Work

Address issues and update for WSARA and DoDI 5000.02*:

* And also recent NDIA-SE report on DOD/SE Systemic Root Cause Analyses findings and associated actions

Director, SE Directive	**Coordinate and obtain USD(AT&L) approval**
Contracting for SE	**Expand beyond current Milestone B focus**
Data Management	**Provide guidance to DoD data managers**
New Guidance	**Fill in policy implementation voids**
SEP Prep Guide	**Reduce internal and external redundancy; update**
DAG Chapter 4	**Update for WSARA**
SE Standards	**Revitalize SE involvement**

Integration of Operational Simulations with Physics-Based Models for Engineering Analysis

Stephen Guest
Henson Graves

October 2009

Outline

- Engineering Analysis and Requirements
- Integration of Operational Simulations with physics based models – an effective approach
- Examples
- Use of MBSE for Integration
- Conclusion

Engineering Analysis is Performed to:

- Understand requirements
- Determine feasibility
- Evaluate proposal design
- Solutions verification

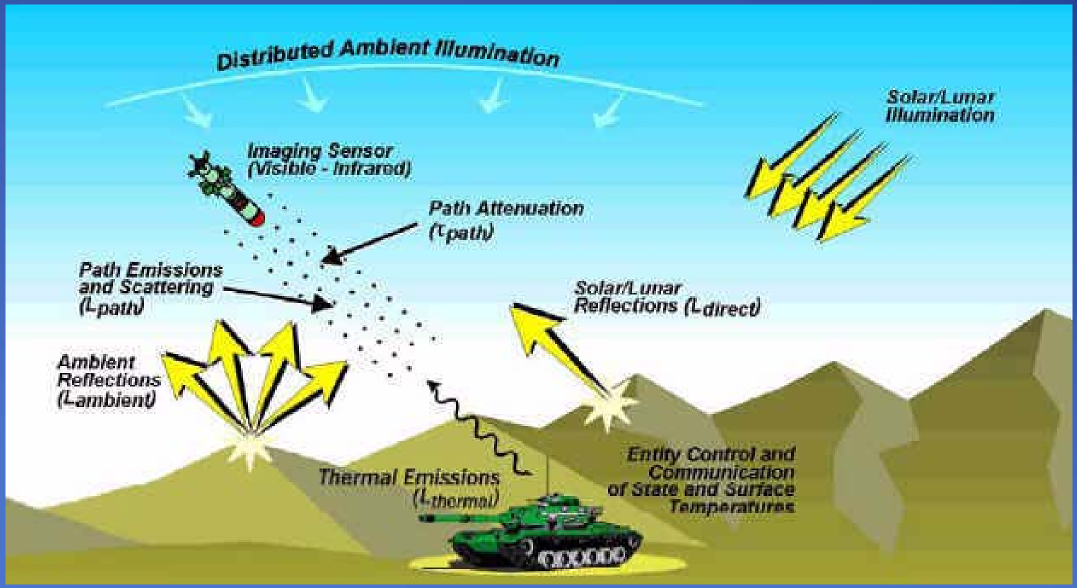
May be for new systems or upgrades

Results of Analysis

- Provide quantitative prediction of behavior with evidence to back it up
- Examples
  - Aircraft performance
  - Sensor analysis
  - Mission effectiveness

Problems Encountered in Analysis

- System behavior is complex and depends on complex interactions with the environment
- Need for component models with appropriate levels of fidelity
- Availability of test data for modeling and verification of certain behaviors



SensorPrime from Presagis

Operational Simulations Integrated with Physics Based Simulations

- Operational simulations integrated with physics based simulations include
  - Behavioral models of vehicles interacting with 3D synthetic environment
  - Physics based models of sensors, atmosphere, ballistics, etc.
- Results - perform experiments, collect data, do analysis
  - Must understand fidelity of models
  - And aggregate integrated results as basis for evidence

Problem - M&S is Not Traditionally at the Core of Product Development Processes

- Simulations of air vehicle and subsystem are in common use, but
- Without integration of detailed avionics/system/subsystem models with operational simulation,
- Simulation results are not available in time to affect the design process

Feasibility, Cost, and Accuracy Have Changed Drastically Over Last Few Years

- Hardware/Software improvements
  - Of course it means the cliché of increased performance and lower costs
  - But what it really means is that I can run it on my laptop
  - Increased performance provides opportunity for more useful/higher fidelity models
  - SDKs and XML provide wide ranging interface capabilities

Sensor Display Simulation

First example – sensor slew performance analysis

- We needed to evaluate a sensor's capability to track a target for a given mission/scenario
- Couldn't acquire detailed sensor performance data for the analysis
- So we built the operational scenario and integrated with a perfect sensor tracking model

Sensor simulation results

- Simulation executed and sensor locked to target
- Platform jitter not modeled (important assumption)
- Motion data of sensor captured and max/min rates and accelerations calculated
- End results indicated that the basic aircraft motion does not drive sensor performance requirements (although stabilization with platform jitter may)

Sensor tracking simulation

Second example – sensor resolution analysis

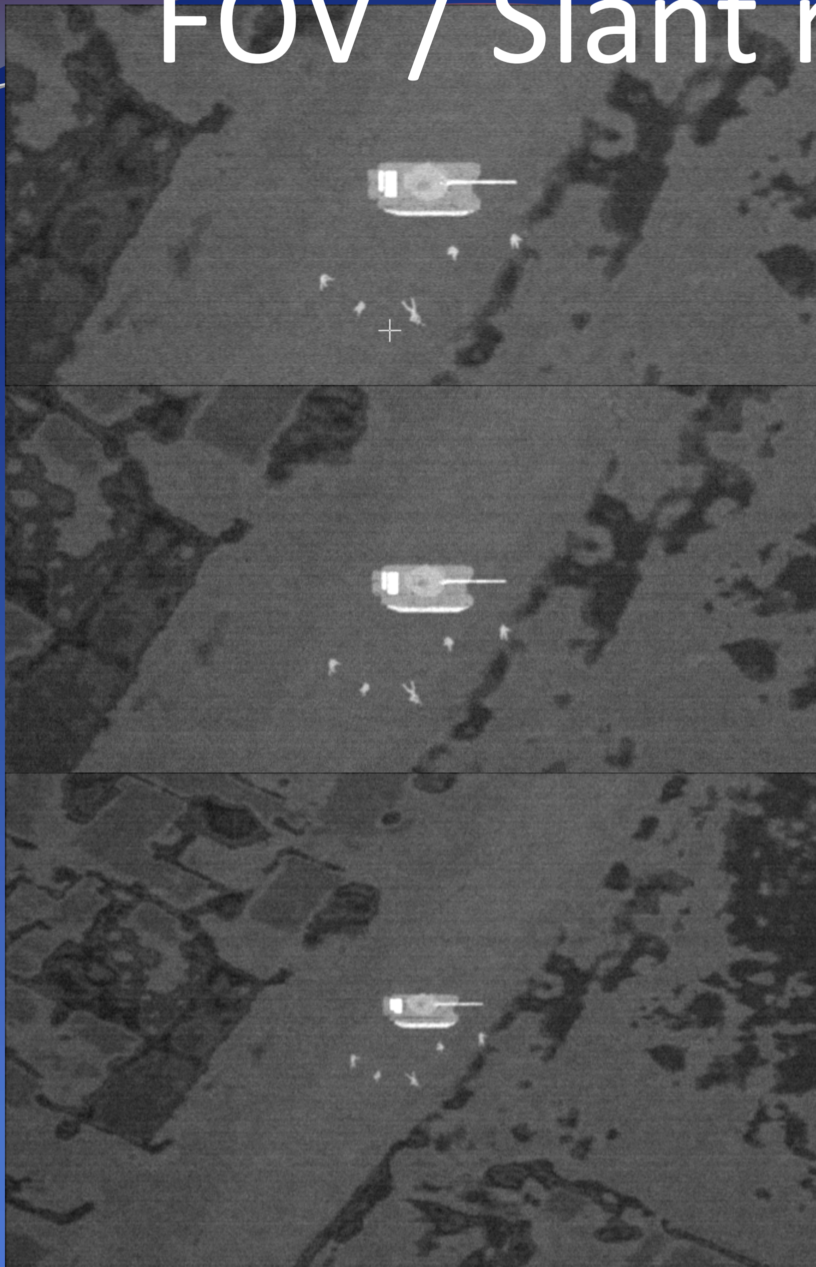
- We wanted to get a feel for what sensor resolution/FOV was needed for target recognition based on
  - Mission profile
  - Multiple resolutions and
  - FOVs (zoom/magnification)
  - Sensor degradation (blur, persistence, etc.)
  - Display characteristics

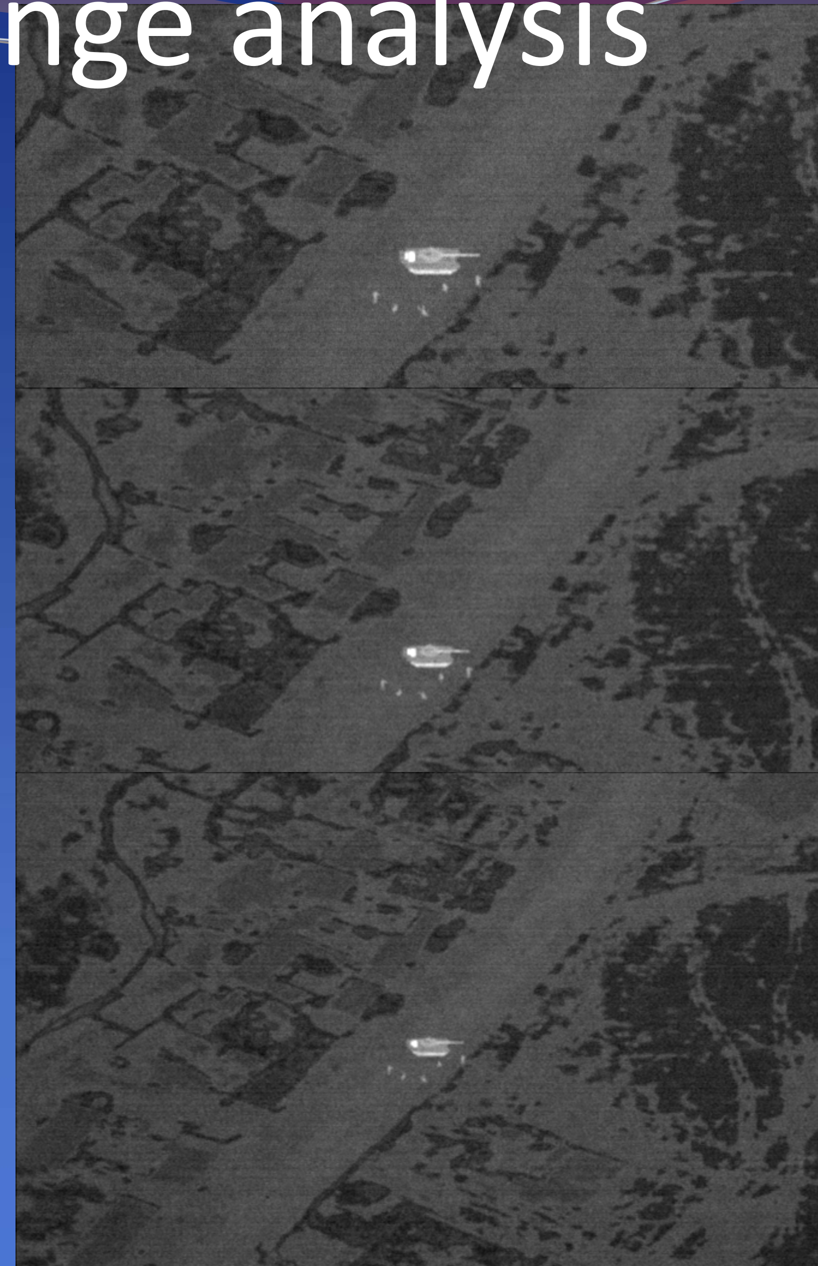
Resolution Analysis (cont'd)

- We could use models like Johnson criteria
  - Certainly valid but not satisfying
  - Provides disconnected subjective results
- Or just build a sensor simulation and evaluate the results
  - Provided direct results - but can still be subjective as one person may make positive identification while another may not

Resolution Analysis

FOV / Slant range analysis



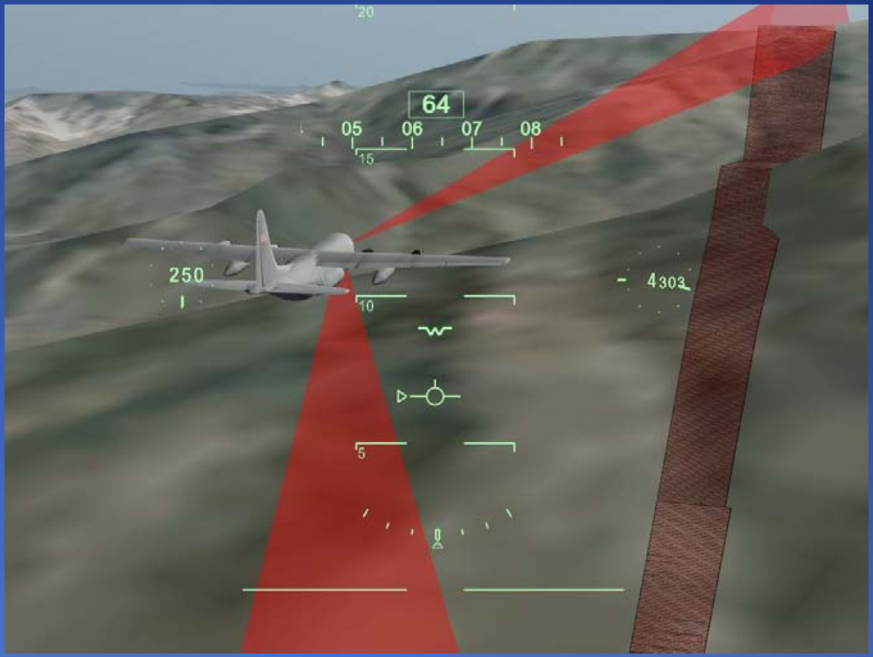


Use of MBSE for Integration

- In order to better establish the link between system simulations and operational simulations, we are investigating the use of MBSE and SysML to define the interfaces and auto-generate code
- This helps
  - Build re-useable and detailed executable design models cost effectively
  - Obtain quantitative analysis results
  - Incorporate the results into the design process

Leveraging SysML Integration

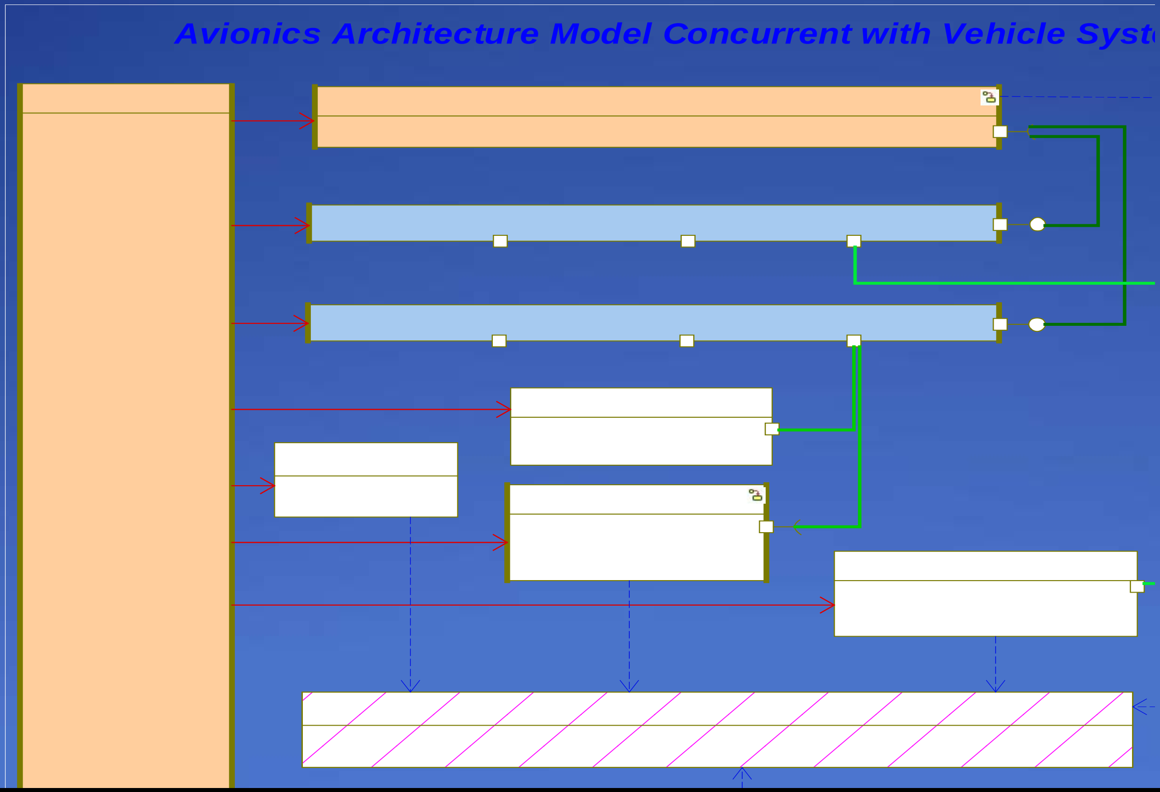
- We used the simulation environment configured with
  - Performance model of aircraft
  - Sensor models
  - Mountains, obstacles, weather, …
- To understand and refine the requirements
- To understand design constraints
  - Aircraft performance
  - Radar performance
  - In specific operational scenarios



Aircraft with radar altimeter and terrain detection radar

Integration of a 1553 Bus with a Terrain Following Simulation

…, and integrated with Simulation



… behavior defined by state charts, uses message table, with statistical assumptions about performance

Conclusions

- The integration of physics based simulations within an operational simulation can be practical
- Building and assembling models, executing distributed simulations, collecting data, and performing analysis within an integrated environment is relatively inexpensive.
- Leveraging an MBSE approach simplifies the creation of an executable architecture and reusable frameworks

Systems Engineering Workforce Development Update

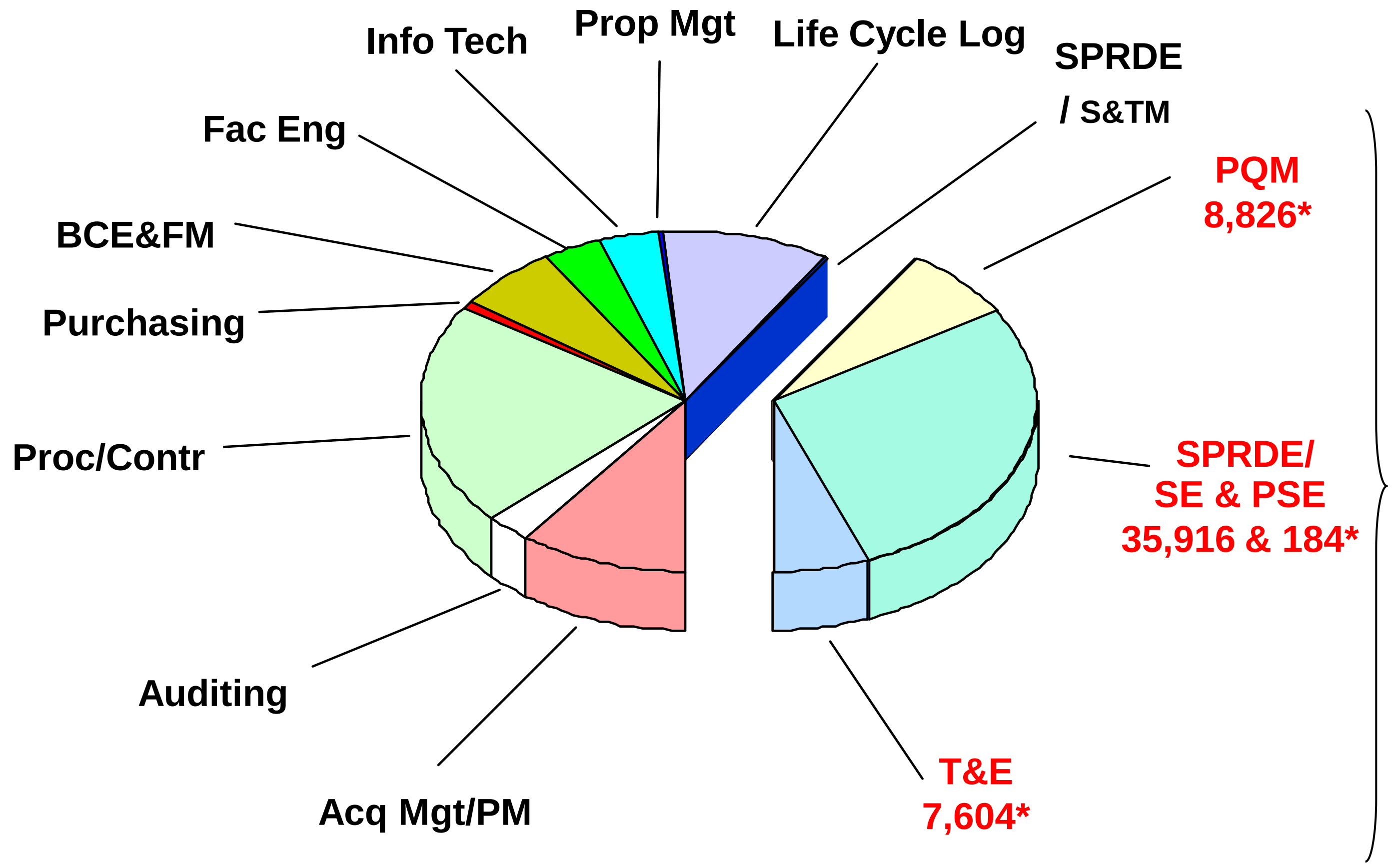
Don Gelosh, PhD, CSEP-Acq
Deputy Director, Workforce Development
Systems Engineering Directorate
Office of the Director, Defense Research and Engineering

12th Annual NDIA Systems Engineering Conference
October 29, 2009

Acquisition Workforce Challenges / Opportunities

- **To increase the success rate of our acquisition programs, we need to:**
  - Better equip / support / enable the workforce to perform successfully and meet all demands
  - Mitigate loss of skilled / experienced workforce
  - Successfully compete for, hire and retain talent
  - Transfer knowledge / expertise to new generation
  - Return "inherently governmental" and other appropriate work from contractors to the government workforce
  - Integrate acquisition workforce planning with DoD Total Force Human Capital Planning
  - Strategically plan and resource human capital initiatives – develop and execute a workforce development roadmap

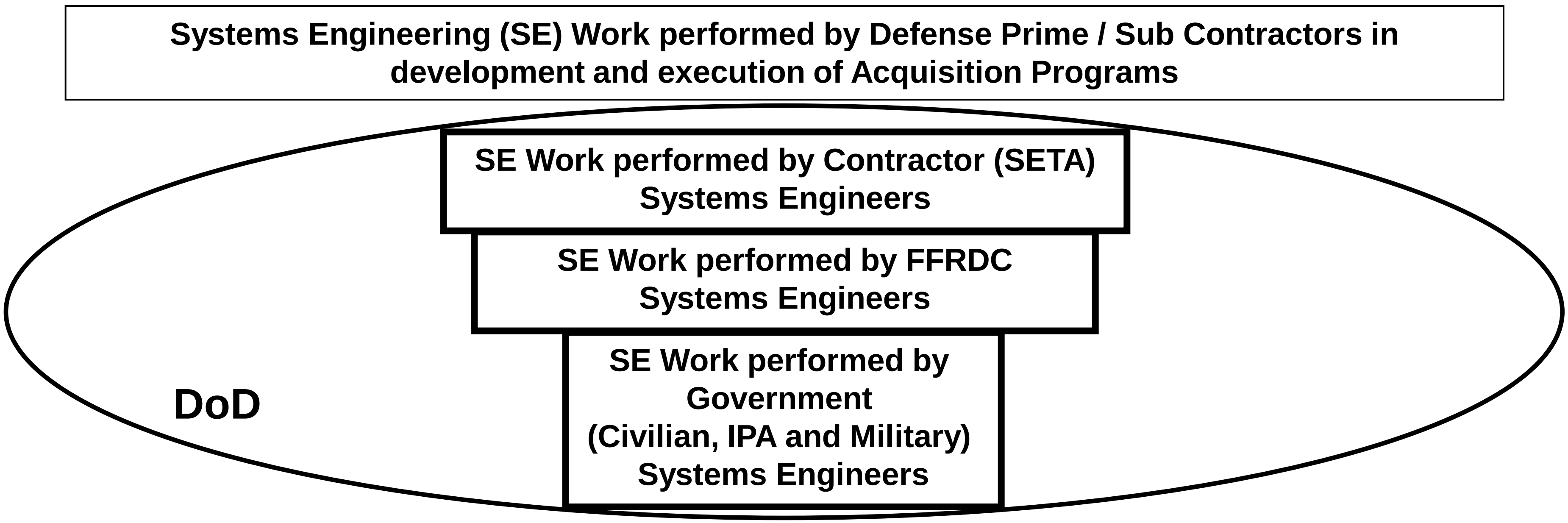
Technical Management Workforce Population



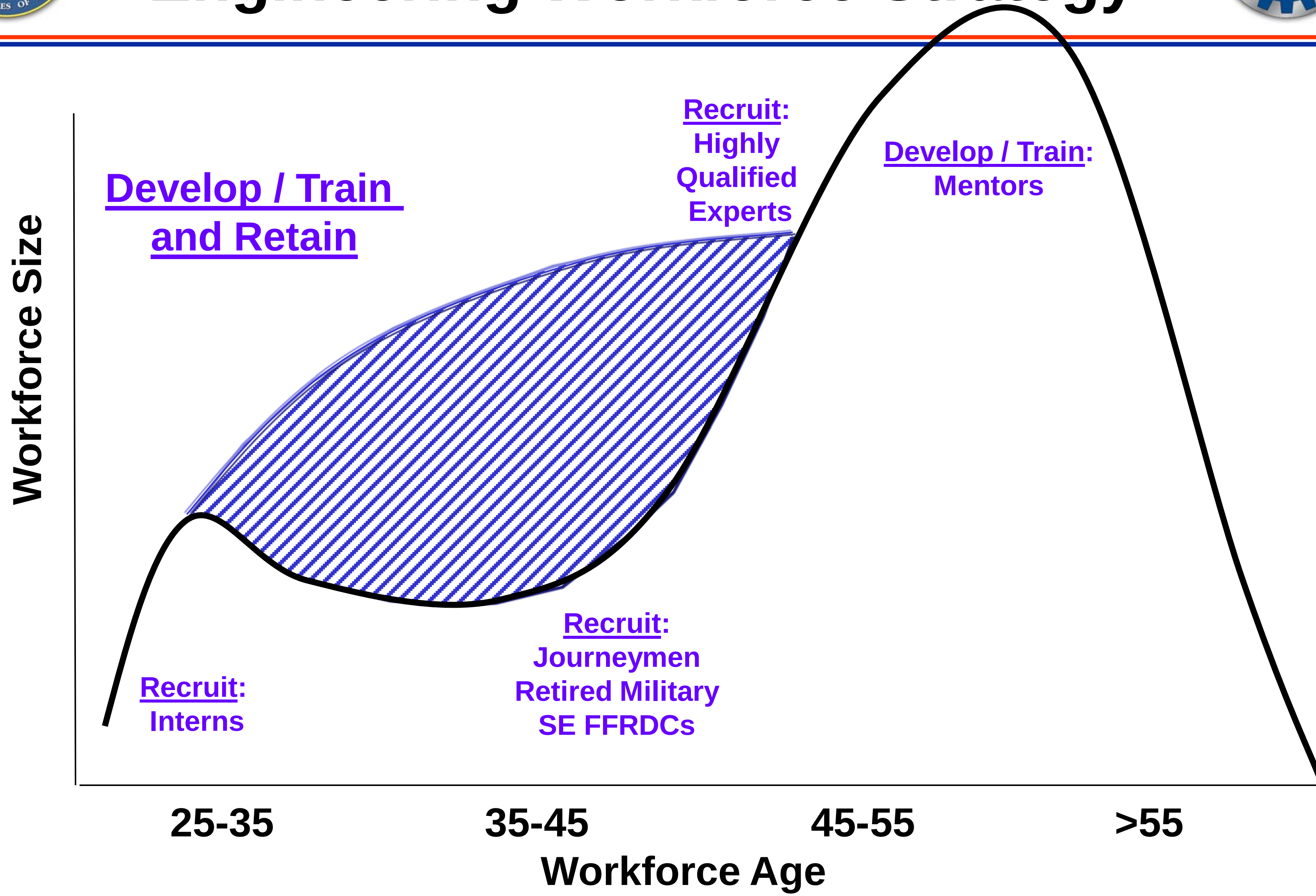
The Defense Acquisition Community
125,047* Government and Military Certified Professionals
Over 50,000 DoD Professionals in SE, T&E and PQM
500,000+ Defense Industry Personnel

*** DAU Data Mart a/o 30 Jun 09**

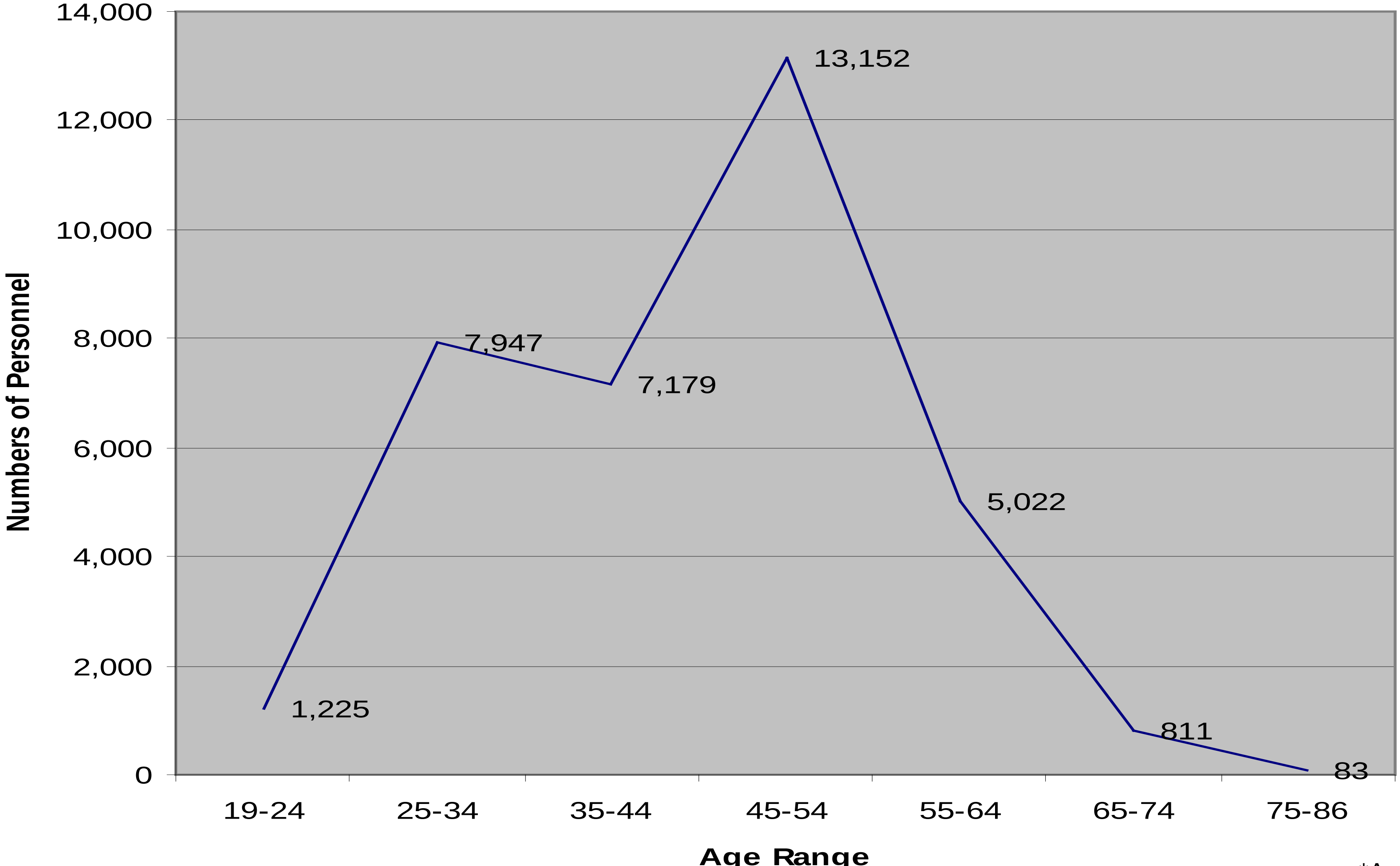
Systems Engineering Workforce Layers



Notional DoD Systems Engineering Workforce Strategy

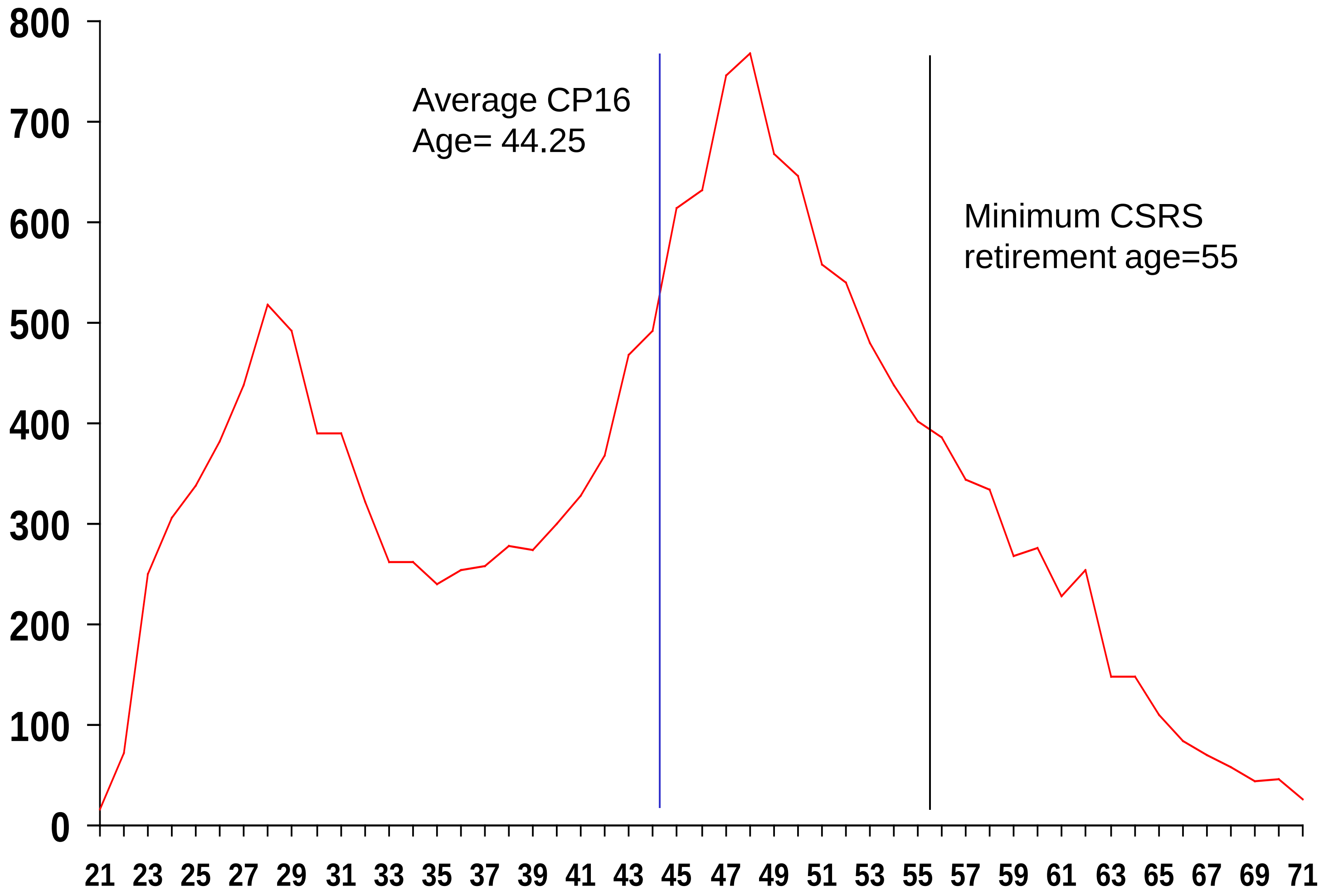


SE Acquisition Workforce Age Demographic* and Notional Strategy



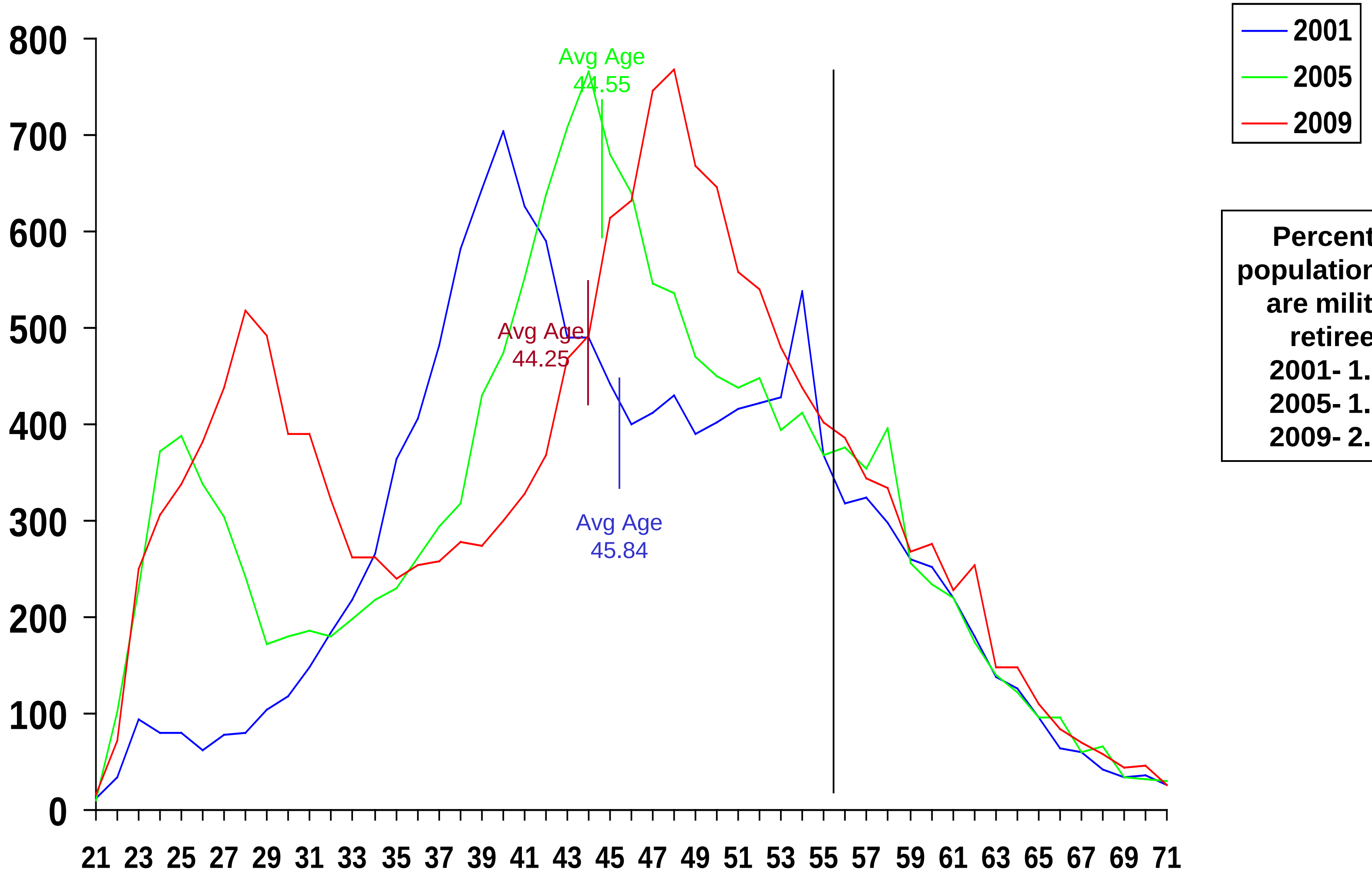
*As of July 2009

US Army RDECOM Career Program 16*
Age Distribution Ages 21-71 only – 2009



* CP 16 includes all Army research and development engineers

US Army RDECOM Career Program 16
Age Distribution Ages 21-71 only – Trend



Percent of population who are military retirees
2001- 1.0%
2005- 1.5%
2009- 2.2%

Projected FY10-15 New Acquisition Government Workforce Distribution

- **20,000 new government billets:**
  - Contractor Conversions to Government = 11,000*
  - New Hires = 9,000
- **Projected Career Field Distribution:**
  - Contracting = 9,500
  - PM, SPRDE/SE&PSE, PQM, LCL, BCEFM, etc. = 10,500
- **Future Workforce Total: 126K + 20K = 146K**
- **Future Contractor Support = 40K (vice 51K currently)**

* Projected at 14 Apr 08 DAU Workforce Conference

Current Systems Engineering (SE) Workforce Picture

- Recent Congressional and GAO reports cite evidence of lack of disciplined systems engineering – indicates gaps in competencies
- Systemic Root Cause Analysis efforts to date indicate lack of systems engineering skills and numbers in the SE workforce
- No clear picture of what competencies are available in the current SE workforce
- SE workforce members may work on a single component for entire career or may work in only one area across several programs
- SE experience standards for certification levels are only specified as number of years spent in coded acquisition positions in specific career fields – not an indication of real experience
- Number of years of experience for current certification levels is too low when compared to industry

Current DoD SE Certification Picture

- Separate functional career fields/paths with little integration of competencies – SE, PSE, T&E, PQM
- Stove-piped approach to certification => less agile workforce
- SE & PSE paths allow for other career field experience; T&E and PQM do not
- Job rotational assignments are not often utilized / emphasized
- Certification is often seen as a check-off list; no real meat behind what a certification means
- SE/PSE and T&E require degrees

What do we want certification to mean?

SE Workforce Challenges / Opportunities

- **What competencies are needed now and in the future and what gaps exist or will exist?**
  - What kinds of Systems Engineers do we need?
  - What is the difference between Systems Engineers and other domain engineers?
- **What workforce capacity do we need now and in the future?**
  - What is the right SE workforce size?
  - How many SEs are needed on any particular program?
- **What is the near-term and long-term workforce capability risk?**
  - How can we manage and mitigate this risk?
- **What key information will help us make sound Systems Engineering human capital strategy / initiative decisions?**
- **How do we leverage NDAA 852 funding?**
  - What should we do in terms of Recruiting?
  - What should we do in terms of Training / Development?
  - What should we do in terms of Retention?

Workforce Development Initiatives

- These initiatives constitute our workforce development roadmap
- Initiatives can be grouped under government, industry and academia categories
- All initiatives are interdependent – each initiative complements, leverages and affects many other initiatives
- Each initiative supports one or more efforts under recruit, train/develop, and retain

Workforce Development Initiatives: Government

- Competency Assessments for Systems Planning, Research, Development and Engineering (SPRDE-SE) and Production, Quality, and Manufacturing (PQM) Career Fields
- New Four Level Certification Standards for SPRDE-SE
- Science, Technology, Engineering, and Mathematics (STEM) Strategic Plan Working Group
- SE Executive Technical Leadership Course (SERC Research Topic)
- Mentoring Workshop/Tutorial at NDIA SE Conference October 26, 2009
- Systems Engineering (SE) Defense Acquisition Workforce Development Fund (DAWDF) Initiative
- Government-to-Government Workshops with Singapore on SE Competency Models
- Occupational Career Code for Systems Engineering (with DAU)

Workforce Development Initiatives: Industry

- **International Council on SE (INCOSE) Certified SE Professional-Acquisition (CSEP-Acq) and Future Extensions**
- **National Defense Industrial Association (NDIA) SE Division Education and Training (E&T) Committee Comparison of Acquisition and Developer Competency Models**
- **Others?**

Workforce Development Initiatives: Academia

- Body of Knowledge and Curriculum for Advanced SE – BKCASE (SERC Research Topic)
- Defense Acquisition Workforce Certification Equivalency with Naval Postgraduate School, Air Force Institute of Technology and Air Force Academy for DAU SYS Courses
- Air Force Academy Preparation Course for INCOSE Associate SE Professional (ASEP) Certification
- SE Education Symposium April 2010 (Co-sponsored with Air Force Academy)
- SE Education and Training Summit 2010
- Working with DAU on SPRDE-SE and PQM Curriculum Currency
- Collaboration with Civilian Universities

Benefits

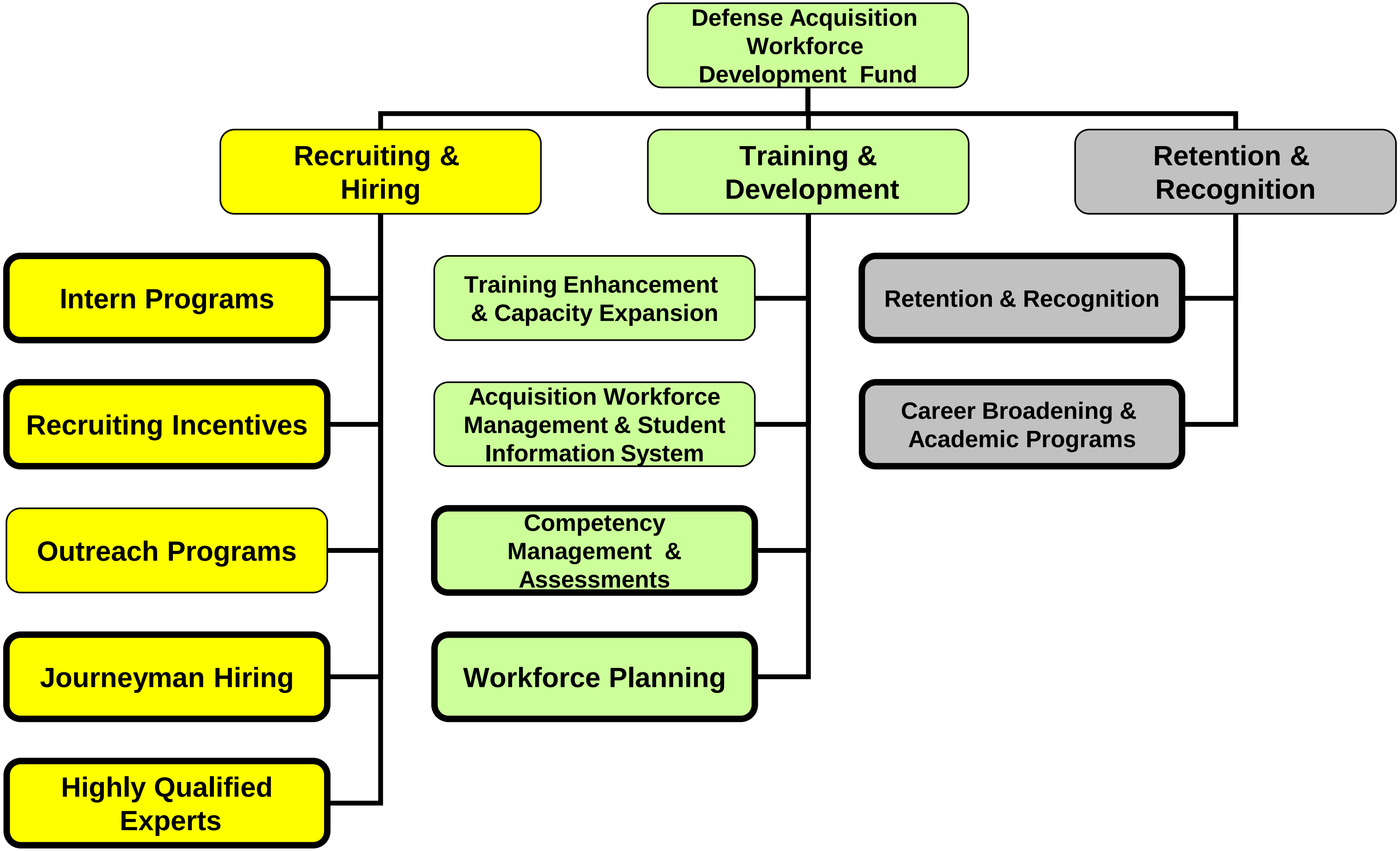
- **All of these initiatives directly contribute to "raising the bar" for Systems Engineering across the board by:**
  - **Enabling us to assess the entire DoD Systems Engineering workforce across critical competencies**
  - **Enabling us to better determine shortfalls in both competencies and workforce size at all levels**
  - **Enabling us to better manage workforce development requirements and certification standards**
  - **Enabling us to make better decisions about human capital strategy and initiatives for the Systems Engineering workforce**
  - **Enabling us to provide acquisition programs with the quantity and quality of Systems Engineers they need for success**

Questions?

BACKUP

UNCLASSIFIED

Human Capital Initiatives
(Defense Acquisition Workforce Development Fund [1])



[1] Based on NDAA Section 852, Defense Acquisition Workforce Development Act

Draft Science, Technology, Engineering and Mathematics (STEM) Education and Outreach Strategic Plan

U.S. DEPARTMENT OF DEFENSE
DEFENSE RESEARCH AND ENGINEERING

SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) EDUCATION AND OUTREACH STRATEGIC PLAN

VISION

A diverse world-class STEM talent pool with the creativity and agility to meet national defense needs

MISSION

Inspire, develop and attract the STEM talent essential to create innovative solutions for the Nation's current and future challenges

INSPIRE	DEVELOP	ATTRACT	DELIVER
A Nation of students, parents, teachers and the public inspired to engage in STEM discovery and innovation	A future world-class STEM workforce talent pool	A dynamic and innovative work environment in the DoD that attracts and retains world-class STEM talent	A coordinated, collaborative and cohesive set of DoD STEM programs
OBJECTIVES • Increase the awareness and importance of STEM to foster discovery and innovation. • Provide opportunities and resources for learning and personal growth that stress academics, knowledge, skills and attributes required for STEM discovery and innovation. • Strengthen, expand and enable communities of stakeholders to provide a continuum of formal and informal education programs and opportunities. • Directly engage populations underrepresented in STEM fields.	**OBJECTIVES** • Identify current and future workforce needs. • Increase the diversity of participants in STEM programs. • Build a portfolio of DoD STEM programs to develop the desired competencies of the talent pool.	**OBJECTIVES** • Identify programs and best practices that attract and retain world-class STEM talent. • Ensure a DoD workplace environment that attracts and retains world-class STEM talent. • Strengthen and promote the awareness of STEM-relevant opportunities within DoD.	**OBJECTIVES** • Develop a systematic approach to identify STEM education and outreach programs across the DoD components and agencies. • STEM Development Office will provide and maintain a publicly-accessible inventory of DoD STEM programs. • Develop a STEM inventory communication strategy.

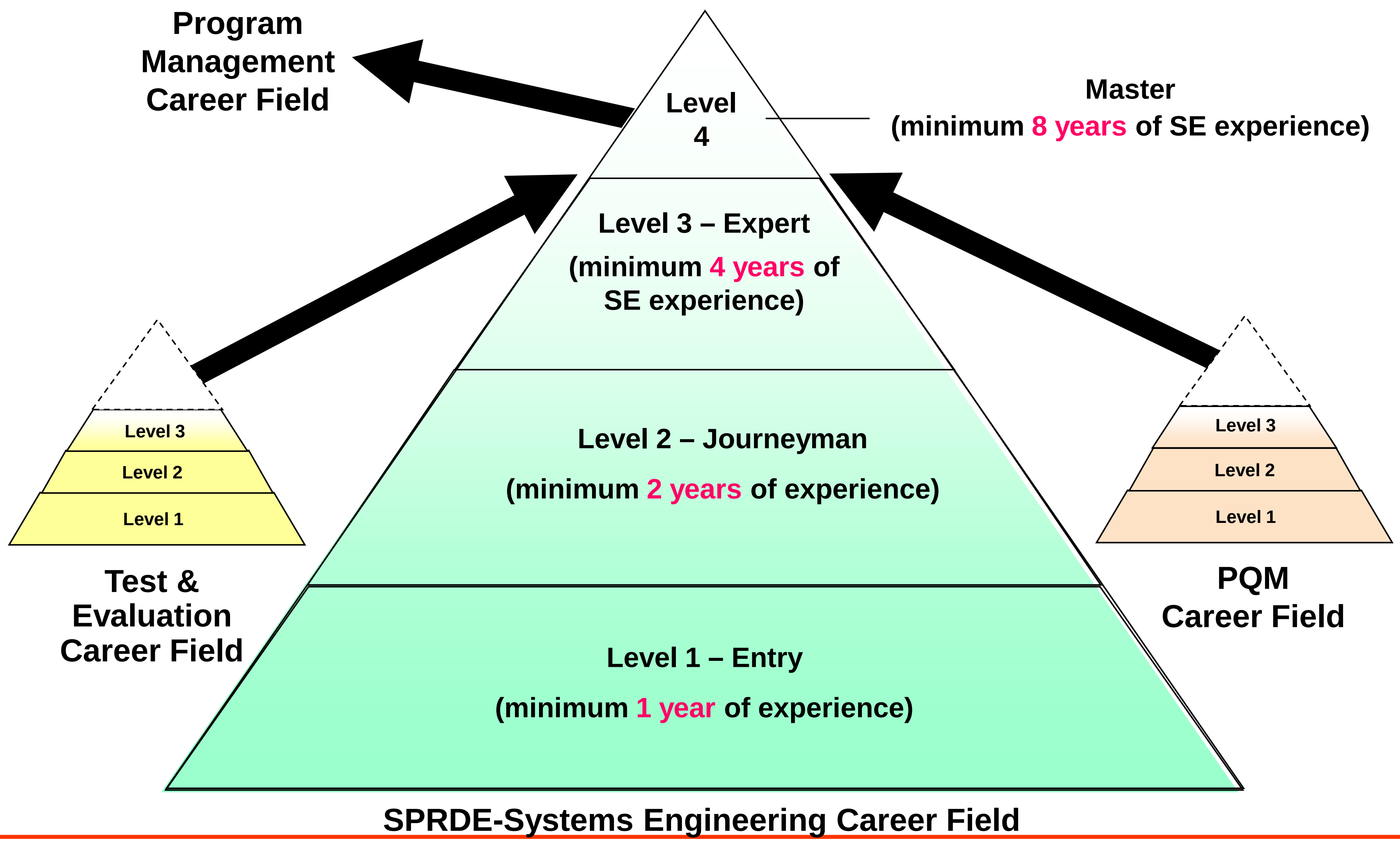
DoD STEM Development Office

DoD DDR&E STEM DEVELOPMENT OFFICE – 10/21/09 - Dr. Laura Adolfie – 703-588-1479

Science, Technology, Engineering and Mathematics (STEM) Education and Outreach Strategic Plan

- **Vision: A diverse world-class STEM talent pool with the creativity and agility to meet national defense needs.**
- **Mission: Inspire, develop and attract the STEM talent essential to create innovative solutions for the nation's current and future challenges.**
- **Goals:**
  - **INSPIRE: A nation of students, parents, teachers and the public inspired to engage in STEM discovery and innovation**
  - **DEVELOP: A future world-class STEM workforce talent pool**
  - **ATTRACT: A dynamic and innovative work environment in the DoD that attracts and retains world-class STEM talent**
  - **DELIVER: A coordinated, collaborative and cohesive set of DoD STEM programs**

Professional Growth to Program Management



The Human in the System:
Integrating the Human into the system
Integrating HSI Tools into Systems Engineering

Jennifer McGovern Narkevicius, PhD

Jenius LLC

JENIUS Solutions

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The entire world is built for human manipulation

Systems Thinking

- Look at the needed outcome and solutions as a whole
- Look at a system as a dynamic and complex whole
- Have all the contributors participate in the design and implementation of the solution
- Bring *all* the required perspectives together

PROGRAMS

- Unprecedented number of high value, high visibility programs

- Increased attention to the part of humans in all programs

- Cross-program integration becoming significant issue

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What is HSI?

- HSI is a multi-disciplinary strategy for the design and life-cycle support of systems
  - Based on human-centric issues
  - Executed as a systems engineering activity
  - Requires unique mind-set to system design
- HSI is a concurrent engineering process
- Main concerns:
  - Maximize Total System Performance
  - Minimize Life Cycle Cost

TOTAL SYSTEM ENGINEERING

Hardware

Software

People

Probability of success

Operational Availability

Readiness to perform

TOTAL SYSTEM PERFORMANCE

Measurable and Certifiable

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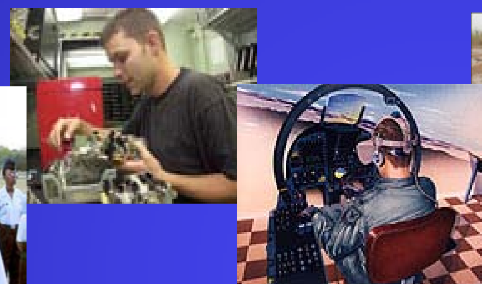
HSI Domain Considerations



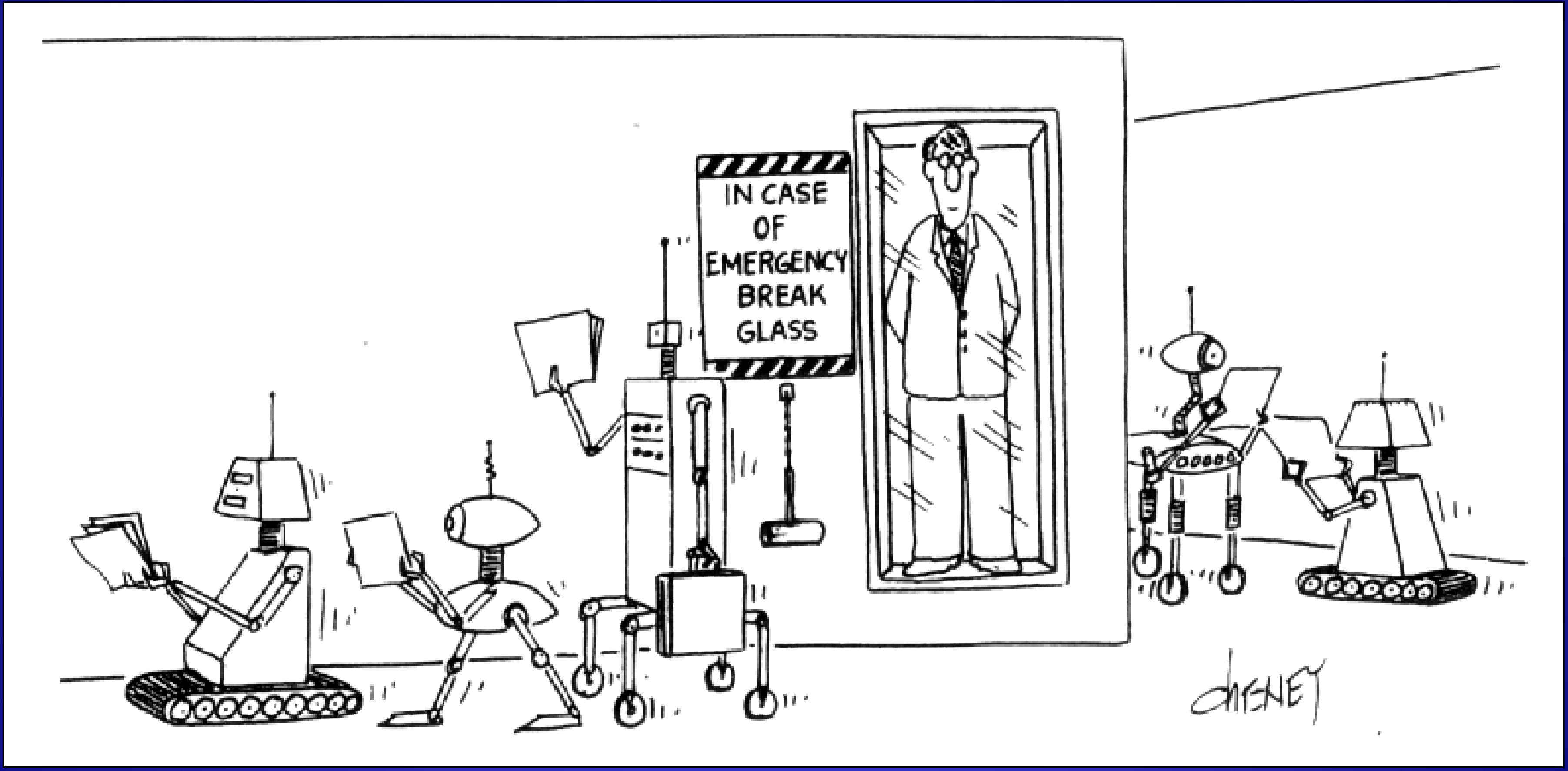
Human Factors Engineering

Manpower, Personnel, & Training

Habitability & Personnel Survivability

Safety, Enviro & Occ Health

There is no such thing as an Unmanned System

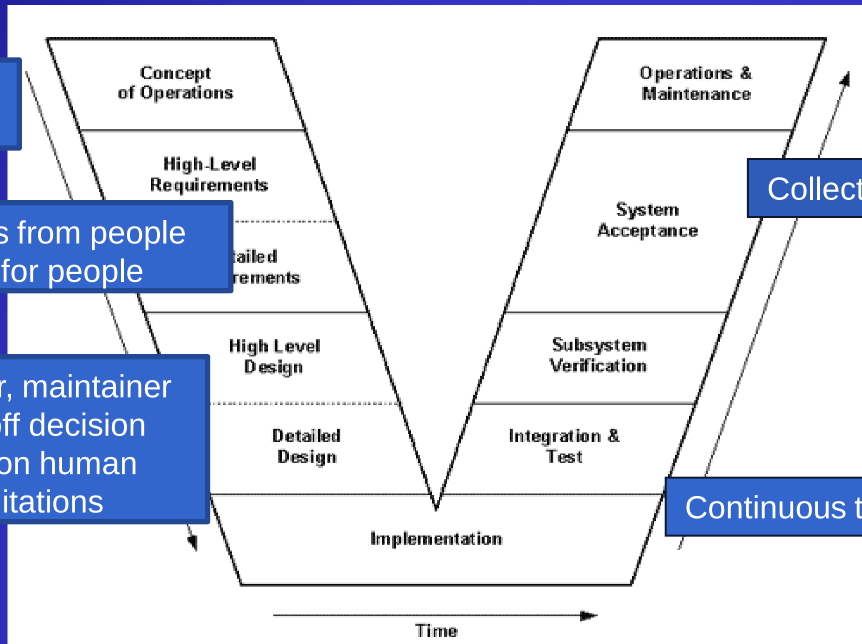


HSI in SE

Define user
Define user intent

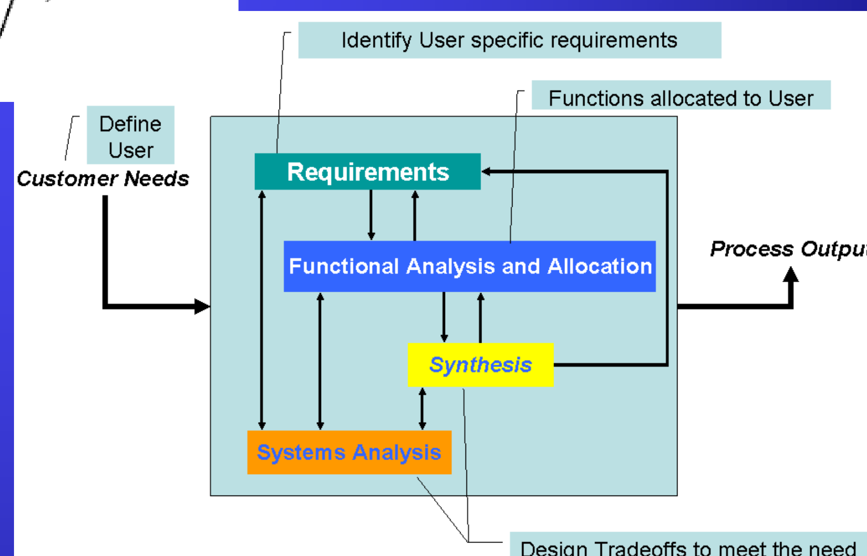
Define requirements from people
Define requirement for people

Design for operator, maintainer
Incorporate trade off decision information based on human capabilities and limitations



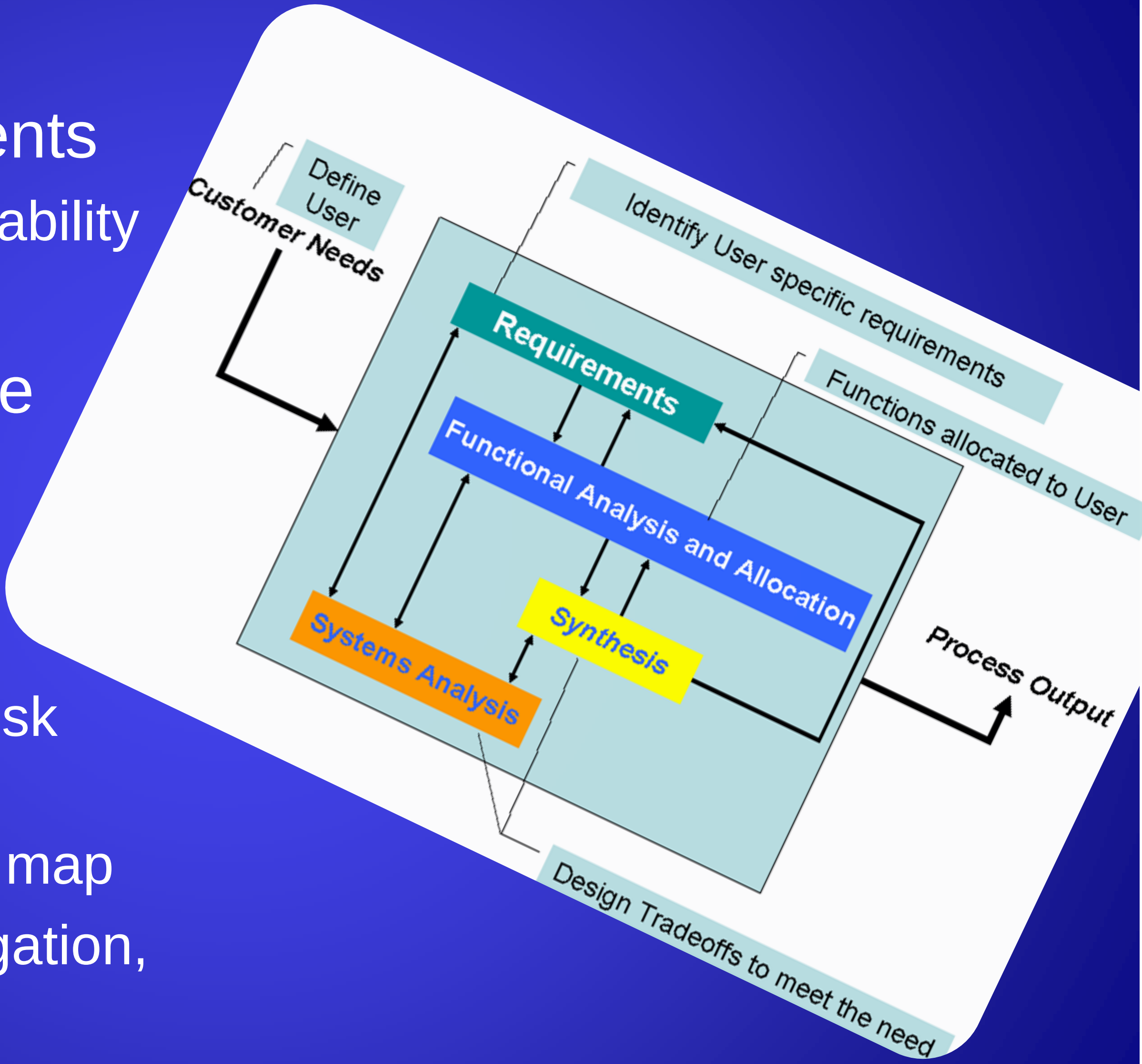
Collect lessons learned

Continuous test/validation



SE Tools

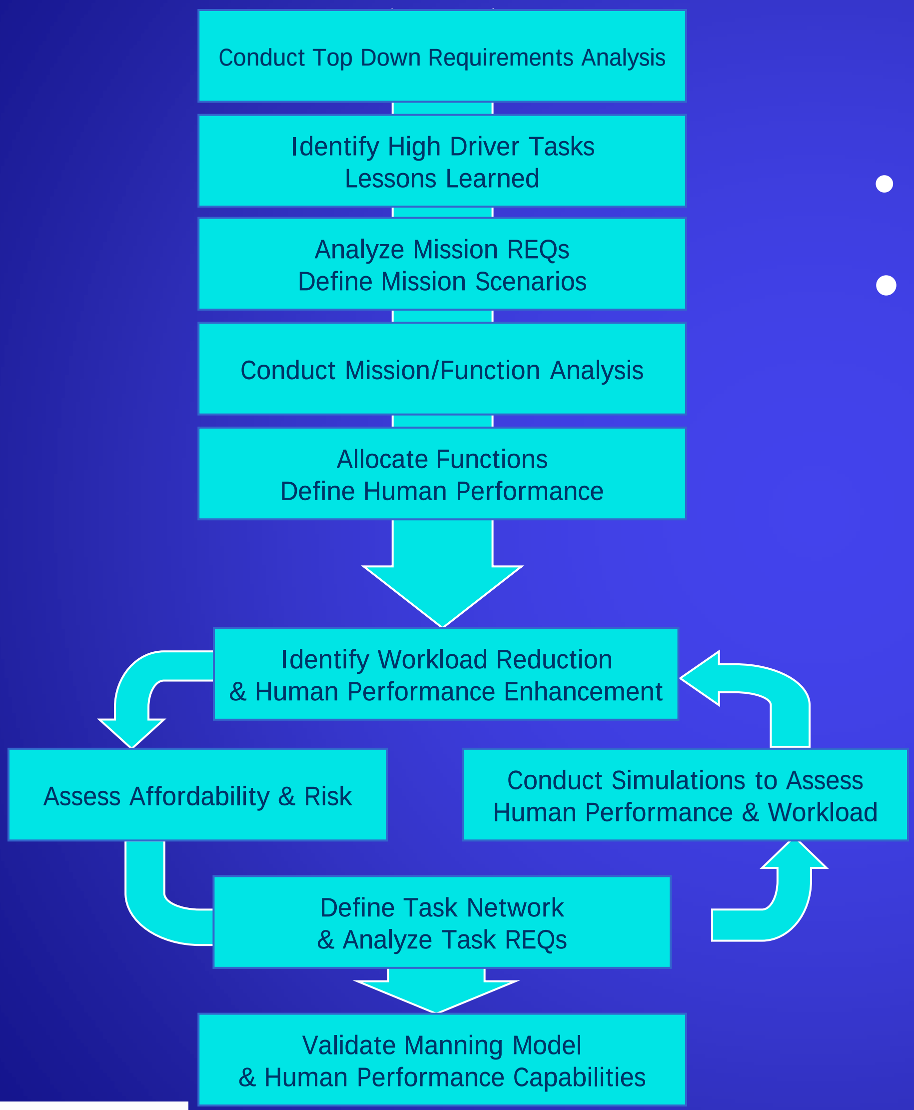
- Manage Requirements
  - Requirements traceability
- Maintain control of systems architecture definition
- Measurement
  - Decision Support/Risk bias mitigation
  - Roadmap/Progress map
  - Risk reduction, mitigation, tracking



HSI Tools

- Requirements Definition
  - Top Down Requirements Analysis/Top Down Functional Analysis
  - Operation Decomposition
- Management/Planning
  - Human Systems Integration Plan
- Measurement
  - Domain Specific
- Design Definition and Refinement
  - Operational Sequence Diagram
  - Modeling tools
  - Prototyping and simulation
  - Usability Engineering Process

Top-Down Requirements Analysis

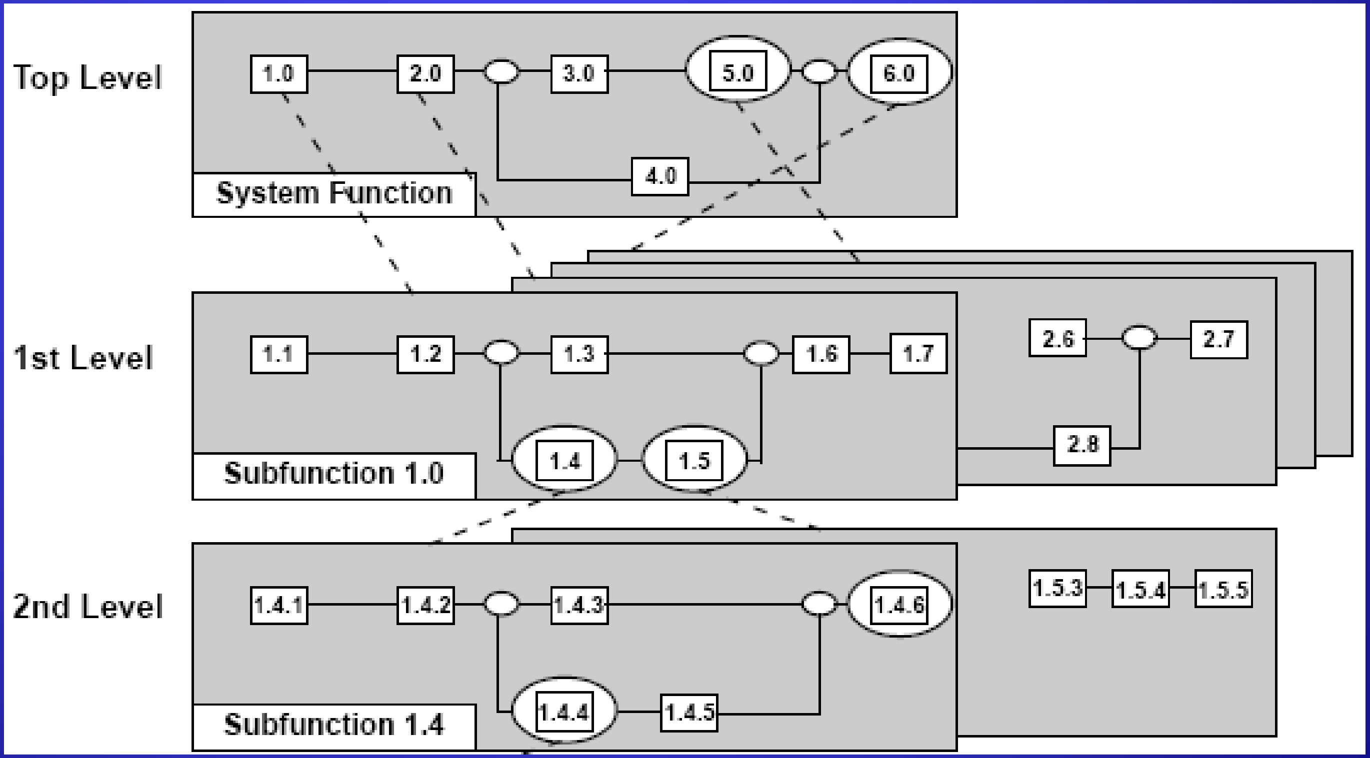


- Front-end of HSI Process
- Provides analyzed requirements, allocation concepts, workload estimates, human task models, system metrics, & manning models

Functional Flow Block Diagram

Functional decomposition

- Traceable to requirements
- Temporal sequences
- Links system level elements to design elements



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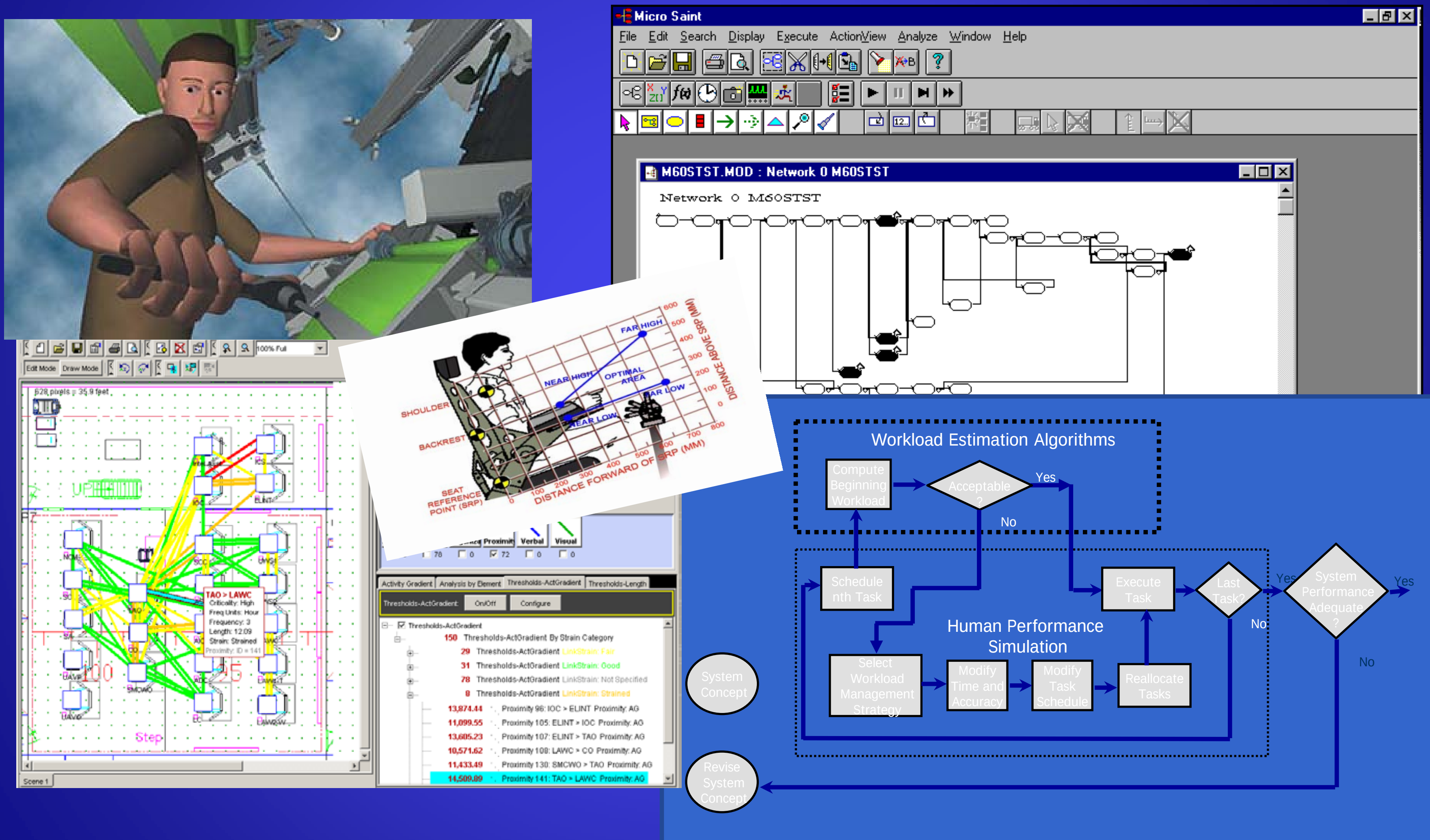
Modeling, Prototyping and Simulation



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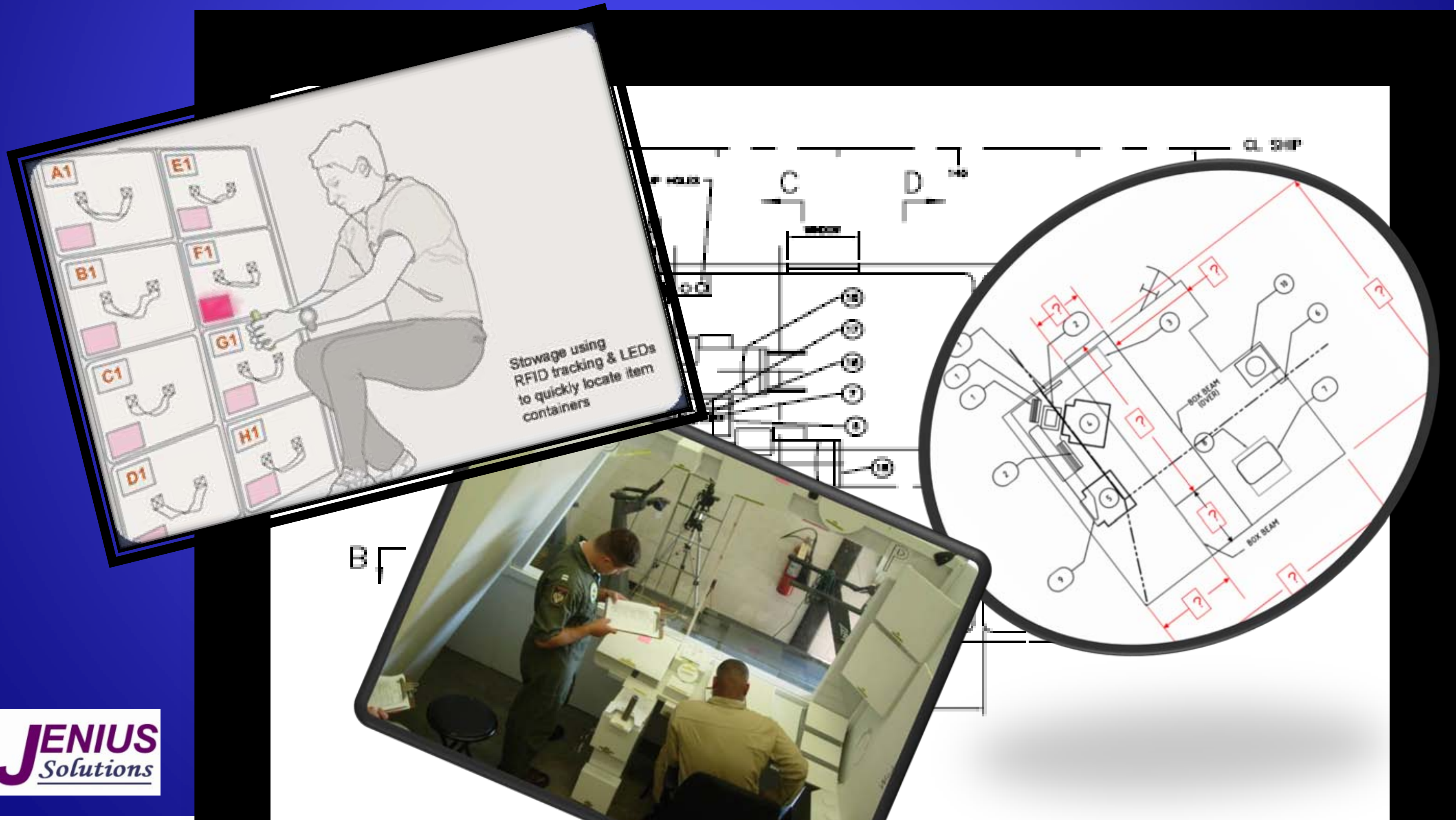
Mockups

Consider all of the design factors to assess the <u>implications and suitability of the design trades</u> made…Use structured, low-fidelity assessments with trained users to identify significant issues that should be addressed early



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Linkage between Tools

HSI TOOLS

- Requirements Definition
- Management/Planning
- Design Definition and Refinement
- Measurement

SE TOOLS

- Requirements Management
- Management Planning
- Maintain control
- Measurement

Challenges

- Linking tools together
  - Actually passing data between tools
  - Without losing functionality, information, clarity, “validity”
- Focusing on the really important stuff
  - Its not the tool
  - The tool is just a tool…it’s what you do with the output that matters
- Maintenance
  - It is not enough just to build a tool
  - Tools should both be maintained and be commercially viable
- Tools must be integrated
  - Across technical disciplines
  - Across questions of technical interest
  - Across phases of development

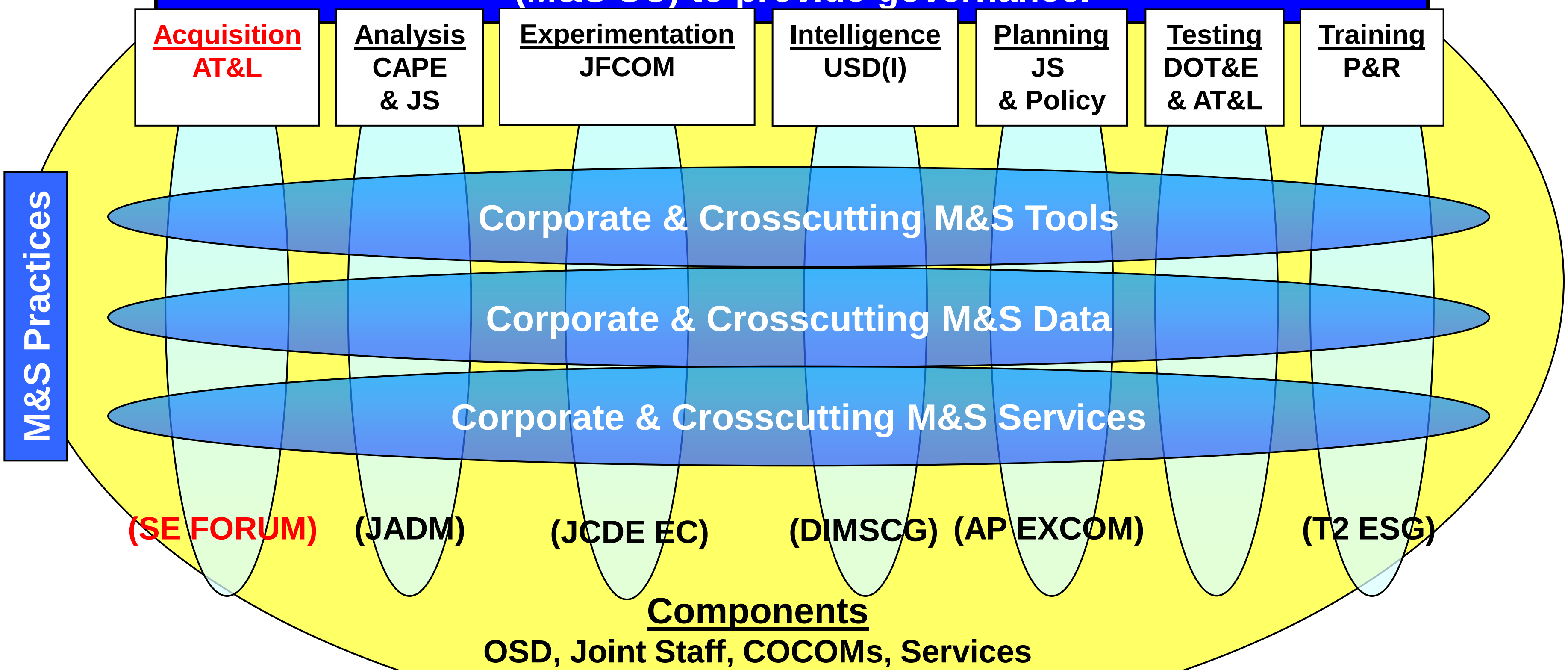
DoD Modeling & Simulation Verification, Validation & Accreditation (VV&A): The Acquisition Perspective

NDIA Presentation Number 8939

Mr. Michael Truelove
ODDR&E/Systems Engineering/Mission Assurance
October 29, 2009

DoD Modeling & Simulation (M&S) Governance

M&S Management Structure Organized by Communities.
Designed to Support & Integrate M&S Activities across the Department.
Led by a Senior Level M&S Steering Committee (M&S SC) to provide governance.



Goal: Establish corporate M&S management to address DoD goals: Leads/guides/shepherds the $Bs in DoD M&S investments; adds value thru metrics & ROI-driven priorities; and seeks to provide transparency.

Acquisition M&S Working Group Relationships

Industry

SISO

INCOSE

NDIA
SE Division

SLC Forum

INCOSE MBSE WG

NDIA
M&S Committee

Chair: Jim Coolahan

DoD Acquisition

Chair: Mr. Stephen Welby
OUSD(AT&L)/DDR&E/SE

Systems Engineering Forum

Acquisition
M&S Working Group

Chair: Col Eileen Bjorkman, USAF
SAF/XCDM

DoD M&S

Mr. Nicholas Torelli
Acquisition Member:
OUSD(AT&L)/DDR&E/SE/MA

M&S Steering Committee

M&S Integrated Product Team

Mr. Mike Truelove (Ctr)
Acquisition Member:
OUSD(AT&L)/DDR&E/SE/MA

AMSWG Charter (SE Forum, 2006)

- Assist PMs and acquisition professionals by improving the utility of M&S . . .
- Address common concerns, improve info flow, align technical initiatives, pursue cross-cutting issue resolution . . .
- Represent the acquisition community in DoD M&S deliberations . . .

Acquisition M&S Master Plan Structure

Department of Defense

Acquisition Modeling and Simulation Master Plan

Issued by the

DoD Systems Engineering Forum

April 17, 2006

1

- **Foreword**
- **Introduction**
  - **Purpose**
  - **Vision**
  - **Scope**
- **Objectives (5)**
- **Actions (40)**
  - **Action**
  - **Rationale** (why it's needed)
  - **Discussion** (implementation guidance)
  - **Lead & supporting organizations**
  - **Products** (what is expected)
  - **Completion goal (year)**
- **Execution Management**

AMSMP: Five Objectives, 40 Actions

Objective 1

Provide necessary policy and guidance

- 1-1 M&S management
- 1-2 Model-based systems engineering & collaborative environments
- 1-3 M&S in testing
- 1-4 M&S planning documentation
- 1-5 RFP & contract language
- 1-6 Security certification

Objective 2

Enhance the technical framework for M&S

- 2-1 Product development metamodel
- 2-2 Commercial SE standards
- 2-3 Distributed simulation standards
- 2-4 DoDAF utility
  - a) DoDAF 2.0 Systems Engineering Overlay
  - b) Standards for depiction & interchange
- 2-5 Metadata template for reusable resources

Objective 3

Improve model and simulation capabilities

- 3-1 Acquisition inputs to DoD M&S priorities
- 3-2 Best practices for model/sim development
- 3-3 Distributed LVC environments
  - a) Standards
  - b) Sim/lab/range compliance
  - c) Event services
- 3-4 Central funding of high-priority, broadly-needed models & sims
  - a) Prioritize needs
  - b) Pilot projects
  - c) Expansion as warranted

Objective 4

Improve model and simulation use

- 4-1 Help defining M&S strategy
- 4-2 M&S planning & employment best practices
- 4-3 Foster reuse
  - a) Business model
  - b) Responsibilities
  - c) Resource discovery
- 4-4 Info availability
  - a) Scenarios
  - b) Systems
  - c) Threats
  - d) Environment
- 4-5 VV&A
  - a) Documentation
  - b) Risk-based
  - c) Examination
- 4-6 COTS SE tools
- 4-7 M&S utility in Acqn metrics

Objective 5

Shape the workforce

- 5-1 Definition of required M&S competencies
- 5-2 Harvesting of commercial M&S lessons
- 5-3 Assemble Body of Knowledge for Acqn M&S
- 5-4 M&S education & training
  - a) DAU, DAG & on-line CLMs
  - b) Conferences, workshops & assist visits
- 5-5 MSIAC utility

Key

Broader than Acqn

Acquisition M&S Community Recognizes Importance of VV&A

- **VV&A of M&S is important because it:**
  - Provides an understanding of the assumptions, capabilities, and limitations of the models and simulations
  - Provides a means for knowing how trustworthy the M&S results are
  - Promotes reuse of M&S by allowing others to understand how the M&S has been used
- **Three specific actions for VV&A are in the Acquisition M&S Master Plan (AMSMP):**
  - Action 4-5 (a): Require DoD-wide standardized documentation of VV&A
  - Action 4-5 (b): Develop a risk-based methodology & associated guidelines for VV&A expenditures
  - Action 4-5 (c): Examine the relevant VV&A when M&S informs major acquisition decisions. Unambiguously state the purpose, key assumptions, and significant limitations of each model or simulation when results are presented

Acquisition Community Commitment to VV&A

- **The Acquisition M&S Community has followed through by taking multiple actions to promote and encourage VV&A:**
  - Sponsored funding to:
    - Finalize the MIL-STD-3022 DoD Standard Practice Documentation of VV&A for Models and Simulations
    - Finalize the DoD VV&A Documentation Tool
    - Establish a risk based approach for VV&A
    - Develop a CMMI-like VV&A maturity model
  - Provided guidance on VV&A in the Defense Acquisition Guidebook
  - Under the Acquisition M&S Working Group, established a VV&A Subcommittee
  - Recommended improvements to the new DoDI 5000.61
  - Volunteered to participate in NATO VV&A activities

Acquisition Commitment to VV&A: Sponsored Funding

- **MIL-STD 3022:**
  - The effort was initiated by the Navy and the Acquisition Community saw value that benefited the M&S enterprise & sponsored its completion
  - The purpose of the standard is to provide a common framework for sharing information throughout the VV&A processes
  - The common method of documentation benefits participants in the VV&A processes by eliminating unnecessary redundancy and facilitating reuse of information when accrediting an M&S for an intended use
  - Was published in January 2008 & has received positive feedback from users
  - Enables the efficient reuse of VV&A information to include discoverability, accessibility, & usability
  - Provides a common way of documenting information about VV&A of M&S
  - Allows information about VV&A projects to be machine searchable thereby promoting reuse

Acquisition Commitment to VV&A: Sponsored Funding (cont.)

- **To finalize the DoD VV&A Documentation Tool:**
  - Leveraged efforts started by the Navy
  - Automated production of the MIL-STD 3022 templates
  - Currently 20 customers are using the tool
  - The DoD VV&A Documentation Tool can be accessed through the M&S Coordination Office website:

    http://www.msco.mil/vva_ doc_tool.html

  - Currently requires a Common Access Card (CAC) or External Certification Authority (ECA)
  - We see a commercial documentation standard under SISO as a logical next step

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Acquisition Commitment to VV&A: Sponsored Funding (cont.)

- **To establish a risk-based approach for VV&A**
  - Since there is a cost for verifying & validating models & simulations, the effort is intended to help a M&S user determine how to focus the V&V to get the information needed to accredit the M&S for use.
  - The importance of VV&A is directly related to the criticality of the decision being informed by M&S.
  - This effort started in the spring of 2009 and is scheduled to be completed in the spring of 2011
  - A commercial standard under SISO may follow
- **To develop a Capability Maturity Model Integration (CMMI)-like VV&A maturity model**
  - The primary focus of this task will be the establishment of a CMMI-like maturity model to support a clearer articulation of the level of VV&A that an organization can or should achieve.
  - Task includes the development of a VV&A roadmap that defines the gaps that inhibit efficient and effective VV&A implementation
  - M&S Steering Committee approved funding for FY-10 & FY-11
  - A statement of work has been submitted with an anticipated work start by December 2009

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VV&A Guidance Efforts

- **Strengthened the Defense Acquisition Program Support (DAPS) Methodology for Program Support Reviews (PSRs) by identifying VV&A as a key aspect of a program's M&S strategy.**
- **Developed and provided a M&S tutorial to Assessments and Support that emphasized the importance of VV&A documentation.**
- **Addressed VV&A in multiple college-level courses developed under the "M&S Education for the Workforce" Project**
- **Addressed VV&A in two Defense Acquisition University Continuous Learning Modules:**
  - M&S for Systems Engineering
  - M&S for Test & Evaluation
- **Addressed VV&A in the "M&S Guidance for the Acquisition Workforce" and the Defense Acquisition Guidebook (DAG) Chapter 4.5.8 or go to:**

  http://www.acq.osd.mil/sse/docs/M-S-Guidance-Acquisition-Workforce.pdf

AMSWG VV&A Subcommittee

- **The Chair of the Acquisition M&S Working Group (AMSWG) proposed and established the VV&A Subcommittee in July 2009.**
  - Acquisition is the biggest producer and consumer of VV&A products
  - Congress has expressed interest in metrics with respect to the number of models and simulations with documented VV&A
  - Periodic VV&A technical interchange meetings are needed to:
    - promote the importance of VV&A
    - exchange VV&A information
    - make VV&A information available
    - provide a virtual VV&A brain trust-capability for the Acquisition Community
    - respond to requests for VV&A information
  - Supports Action 4-5 in the AMSMP and Goal 3 of the M&S Steering Committee's Strategic Vision for DoD M&S

Background on DoDI 5000.61

- DoDI 5000.61 DoD Modeling and Simulation (M&S) Verification, Validation, and Accreditation (VV&A) is the Department's instruction that implements policy, assigns responsibilities, & prescribes procedures for the verification, validation, & accreditation (VV&A) of DoD models, simulations, & associated data.
- The latest version of the DoDI 5000.61 was last dated May 13, 2003
- At the July 2007 M&S Steering Committee Offsite, the M&S SC directed a review and update if needed to the DoDI 5000.61
- Office of the Secretary of Defense Program Analysis & Evaluation (PA&E), a member of the Modeling & Simulation Steering Committee, volunteered to lead the effort to revise the instruction in 3 months.
- Their effort ended when the revised instruction began formal staffing for approval in June 2009

DoDI 5000.61: Current Status

- The instruction entered formal SD 106 staffing on June 4, 2009
- Suspense for formal comments was August 11, 2009
- The M&S Coordination Office is led the adjudication process
- Adjudication is nearly complete
- USD (AT&L) Signature is expected by the end of this calendar year

NATO Participation

- NATO has requested more U.S. participation in M&S activities
- The Modeling & Simulation Coordination Office has requested more participation from the Communities and Services
- The Acquisition Community has volunteered to participate in NATO VV&A activities and others
- Coordination with the M&S CO is underway

Summary

- The Acquisition M&S Community is committed to VV&A
- The Acquisition M&S Community wants to further mature the practice of VV&A
- We solicit your support and participation
- Let us know your concerns and suggestions
- We will incorporate and champion good ideas

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Q & A

Acronyms

- **AMSMP**: Acquisition Modeling & Simulation Master Plan
- **AMSWG**: Acquisition Modeling & Simulation Working Group
- **AP EXCOM**: Adaptive Planning Executive Committee
- **AT&L**: Acquisition, Technology and Logistics
- **CAC**: Common Access Card
- **CAPE & JS**: Cost Assessment Program Evaluation & Joint Staff
- **CMMI**: Capability Maturity Model Integration
- **COCOMS**: Combatant Commands
- **DAPS**: Defense Acquisition Program Support
- **DDR&E**: Director, Defense Research and Engineering
- **DIMSCG**: Defense Intelligence M&S Collaboration Group
- **DoD**: Department of Defense
- **DoDI**: Department of Defense Instruction
- **DOT&E**: Director Operational Test and Evaluation
- **ECA**: External Certification Authority
- **INCOSE**: International Council on Systems Engineering
- **JADM**: Joint Analytic Data Management
- **JCDE EC**: Joint Concept Development & Experimentation Executive Committee

Acronyms (cont.)

- **JFCOM**: Joint Forces Command
- **M&S**: Modeling and Simulation
- **MA**: Mission Assurance
- **MBSE**: Model Based Systems Engineering
- **MIL-STD**: Military Standard
- **NDIA**: National Defense Industrial Association
- **ODDR&E**: Office of the Director, Defense Research and Engineerint
- **OSD**: Office of the Secretary of Defense
- **OUSD**: Office of the Under Secretary of Defense
- **P&R**: Personnel and Readiness
- **PSR**: Program Support Review
- **SE**: Systems Engineering
- **SISO**: Simulation Interoperability Standards Organization
- **SLC**: System Life Cycle
- **T2 ESG**: Training / Transformation Executive Steering Group
- **USD(I)**: Under Secretary of Defense for Intelligence
- **VV&A**: Verification, Validation and Accreditation
- **WG**: Working Group

Standards Needs Identified in the Acquisition M&S Master Plan

- Action 1-5 Contracting Guidelines / Best Practices
- Action 2-2 Commercial Systems Engineering (SE) Standards
- Action 2-3 Distributed Simulation Standards
- Action 2-4 DoD Architecture Framework (DoDAF)
- Action 2-5 Metadata Template for Reusable Resources
- Action 3-2 Best Practices for M&S Development
- Action 3-3 Distributed Live, Virtual, Constructive (LVC) Environments
- Action 4-2 M&S Planning Best Practices
- Action 4-5 VV&A
- Action 5-1 Required M&S Competencies
- Action 5-3 M&S Body of Knowledge

Disciplined Systems Engineering & The Foundational Team SE Skill Set

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October 26, 2009

The Issue

- Chief Engineer's are accountable for implementing a disciplined systems engineering process with the skills of the staff they have
  - Staff planning is required content in the Systems Engineering Plan

How does the chief engineer know that the skills of their staff are adequate to implement a disciplined systems engineering process?

What to Do

- Define the minimum collective staff skill set required to implement a disciplined systems engineering process
- Create an assessment tool for the Chief Engineer
  - Identify skills of the current staff
  - Identify gaps between current staff skills and the defined minimum collective skill set
- Publish the minimum collective staff skill set and assessment tool in the appropriate Air Force level document.

Outline of Basic Tasks

- Establish the process
- Develop the skills dictionary
- Assessment tool selection
- Pilot project, wing level
- Draft policy guidance
- Publish policy guidance

Establish the Process

Develop America's Airmen Today ... for Tomorrow

- Who owns the process?
  - Wing/Group/Squadron Chief Engineer?
- Process covers the technical staff
- Process should not require additional manpower

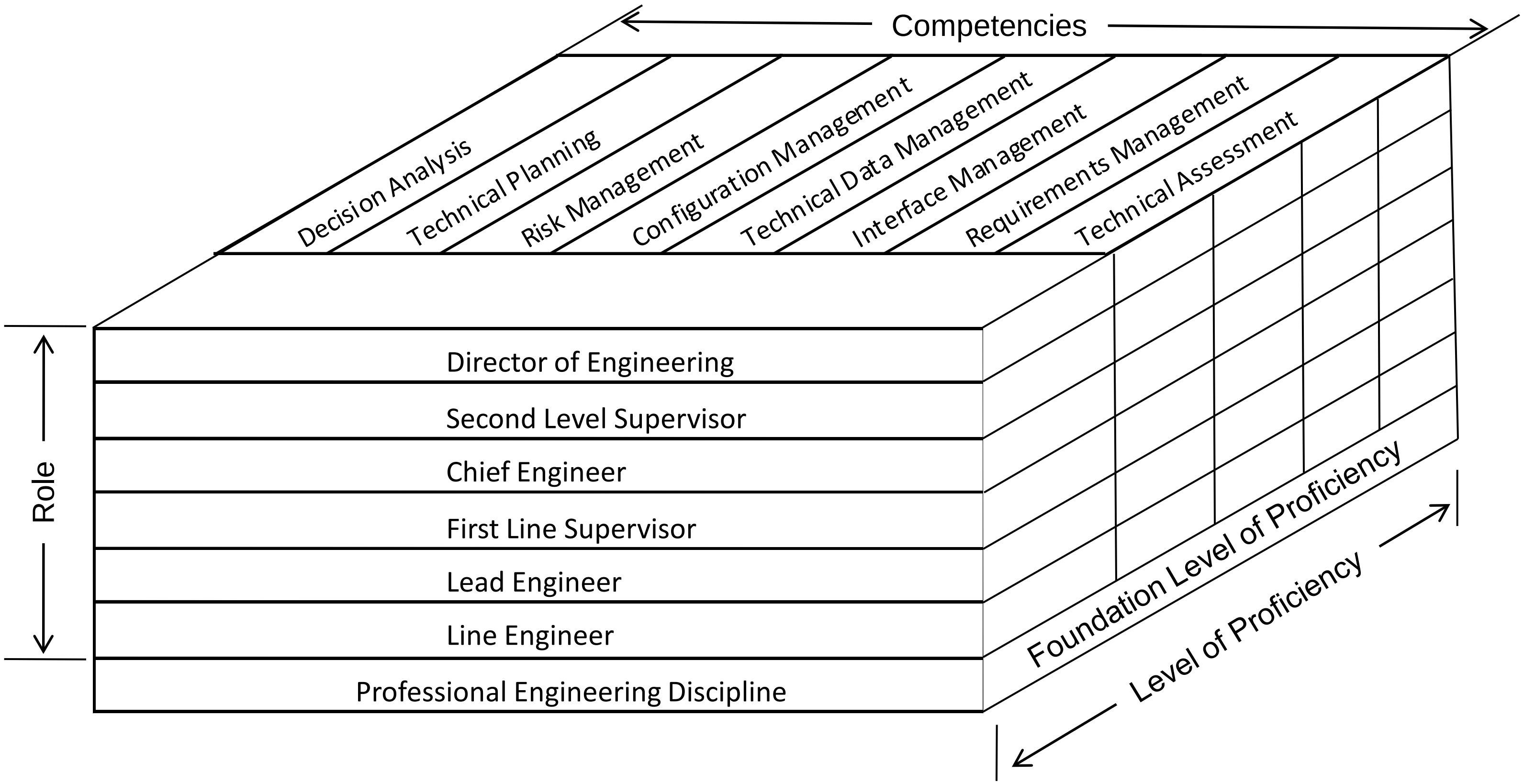
Develop the Skills Dictionary

- Skills should cover SE process execution across the life cycle
  - Not intended to cover detailed skills of experts in a specific technical discipline
- Skill set should be adaptable and capable of easy modification

Team has identified 32 skills within the skills dictionary labeled "Foundational Team SE Skill Set".

Competency Model

Develop America's Airmen Today ... for Tomorrow



Systems Engineering Foundational
Team Competency Model

Decision Analysis
•Can carefully identify the decision at hand and the decision context using appropriate disciplines and disciplined practices
•Can articulate one's objectives in the situation at hand
•Can articulate the benefits of decision analysis
•Can identify the various elements of the situation, i.e. 1) values, priorities and objectives, 2) decisions to be made, 3) certain and uncertain events, 4) consequences, 5) assumptions, 6) limitations and constraints, 7) stakeholders, 8) variation
•Can structure decisions using influence diagrams and/or decision trees and/or other methods and models
•Can structure values and objectives
•Can specify ways to measure achievement of objectives
•Can apply a decision-analysis process
•Can assess the completeness, fidelity, suitability and implications of the decision context

Technical Planning
•Can plan and properly sequence all technical steps
•Can manage risks from out-of-sequence technical steps
•Can manage the application of all relevant technical specialties at the right time
•Can link the technical process with business and management processes
•Can plan and properly sequence all technical review activities
•Can plan and manage testing as well as validation and verification activities
•Can plan and manage technical activities that span the acquisition phases
•Can develop, tailor, implement, integrate and manage the following technical processes: requirements development, logical analysis, design solution, implementation, integration, verification, validation, and transition.

Foundational Team SE Skill Set Slide 2

Develop America's Airmen Today ... for Tomorrow

Risk Management
•Can actively manage risk on a continuing basis across the life cycle
•Can adjust risk handling plans to changing circumstances
•Can identify potential additional risks resulting from interactions between multiple risk sources

Configuration Management
•Can implement control processes that regulate change at all levels of the product hierarchy from the system-of-systems level down to the piece part level

Technical Data Management
•Can implement control processes that regulate the creation, change, dissemination, archiving and retrieval of technical data

Interface Management
•Can implement control processes that regulate the creation of, change to, and agreement with documented descriptions of the physical and functional boundaries at all levels of the product hierarchy.
•Can establish forums for interface management when no single organization has responsibility for the entire product hierarchy.

Foundational Team SE Skill Set Slide 3

Requirements Management

•Can establish control processes that regulate the establishment of, change to, and agreement with a specific documented set of technical requirements at a given level of the product hierarchy.

•Can articulate the effect of user requested changes on documented technical requirements at all levels of the product hierarchy.

•Can identify risks of achieving specific technical requirements for input into the risk management process.

•Can complete trade studies that balance an achievable set of requirements within cost and schedule constraints.

Technical Assessment

•Can establish and use technical performance measures to track achievement of key performance parameters

•Can establish and use leading indicators to monitor the health and status of systems engineering process execution

•Can conduct thorough, comprehensive technical reviews that accurately convey technical progress

•Can use manufacturing and technology readiness levels to judge the risk of achieving desired technical requirements

Tool Selection

- Tool should be easily accessible to chief engineers
- Tool should allow easy skill set adjustments
- Tool should be common across wing/group/squadron
- Tool will be an individual self assessment for all 32 skills identified
    - Proficiency level
    - Importance – aid to judging if we have the correct skill mix
- Supervisor review of individual self assessments

Self Assessment Proficiency Level

- No Skill - neither understands concepts of nor can apply this skill
- Newbie - general understanding of concepts and can apply skill under supervision
- Capable - general understanding of concepts and can apply skill with guidance
- Proficient - depth of understanding of concepts permits independent application
- Expert - leads others in applying this skill and is sought out by others for guidance

Self Assessment Importance

Develop America's Airmen Today ... for Tomorrow

- Not Important - this skill is not important for success
- Useful - this skill is helpful but not necessary for success
- Important - having this skill contributes to success
- Vital - it is not possible to be successful without this skill

Assessment Tool Format

Develop America's Airmen Today ... for Tomorrow

Technical Assessment

Skill 1 - Can establish and use technical performance measures to track achievement of key performance parameters.

Importance		Proficiency Level	
Not Important		No Skill	
Useful		Newbie	
Important		Capable	
Vital		Proficient	
		Expert	

Skill 2 - Can establish and use leading indicators to monitor the health and status of systems engineering process execution.

Importance		Proficiency Level	
Not Important		No Skill	
Useful		Newbie	
Important		Capable	
Vital		Proficient	
		Expert	

Skill 3 - Can conduct thorough, comprehensive technical reviews that accurately convey technical progress.

Importance		Proficiency Level	
Not Important		No Skill	
Useful		Newbie	
Important		Capable	
Vital		Proficient	
		Expert	

Skill 4 - Can use manufacturing and technology readiness levels to judge the risk of achieving desired technical requirements.

Importance		Proficiency Level	
Not Important		No Skill	
Useful		Newbie	
Important		Capable	
Vital		Proficient	
		Expert	

Not Important - this skill is not important for success
Useful - this skill is helpful but not necessary for success
Important - having this skill contributes to success
Vital - it is not possible to be successful without this skill

No Skill - neither understands concepts of nor can apply this skill
Newbie - general understanding of concepts and can apply skill under supervision
Capable - general understanding of concepts and can apply skill with guidance
Proficient - depth of understanding of concepts permits independent application
Expert - leads others in applying this skill and is sought out by others for guidance

Pilot Project, Wing Level

Develop America's Airmen Today ... for Tomorrow

- Analogous to “fly-fix-fly” approach in aircraft acquisition
- Learn as you go and refine the bumps in the road before issuing policy guidance
- Seek willingness to participate at the wing level

303rd AESW will participate in the pilot project.

Draft Policy Guidance

- Coordinate draft within the team
- Refine the draft with lessons learned from the pilot program
- Gain consensus to proceed with formal publication

Protect the Mission, Promote Growth, and Preserve Legacy

Presented by: Patricia Scaramuzzo

SYSTEMS & SOFTWARE INITIATIVE

Challenge

What did the Knowledge Continuity* project seek to do?

FIND EFFECTIVE KNOWLEDGE TRANFER

- *"The problems with transferring deep smarts are many. ..you often don't know what you know or bring it into conscious consideration until you are forced to explain or demonstrate it in response to some specific situation."*
  - *Source: ASK Magazine volume 22, Dorothy Leonard*

- *"In the KM world, a Holy Grail is effective capture, enhancement, persistence, and transfer of knowledge."*
  - *Source: http://myst-technology.com/public/item/53612*

* *Patent Pending*

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Approach

Get "academically smart" on Knowledge Transfer – some examples:

- Deep Smarts: Dorothy Leonard
- Lost Knowledge: David DeLong
- ASK Magazine: NASA

Mine best practices across the corporation

- Identify unique approaches in Knowledge Sharing
- Drill it down into a process

Collaboratively develop a new Knowledge Transfer approach

Pilot, and study results

Expand the practice

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Timeline

- 2003-2005 — **Organic Development**
- **Socialization** — 2005-2007
- 1Q-2Q2008 — **Consolidation of Programs**
- **Pilot** — 3Q2008-2Q2009
- 1Q-2Q2009 — **Refinement**
- **Surge** — 2009

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Results of the Knowledge Continuity Pilot

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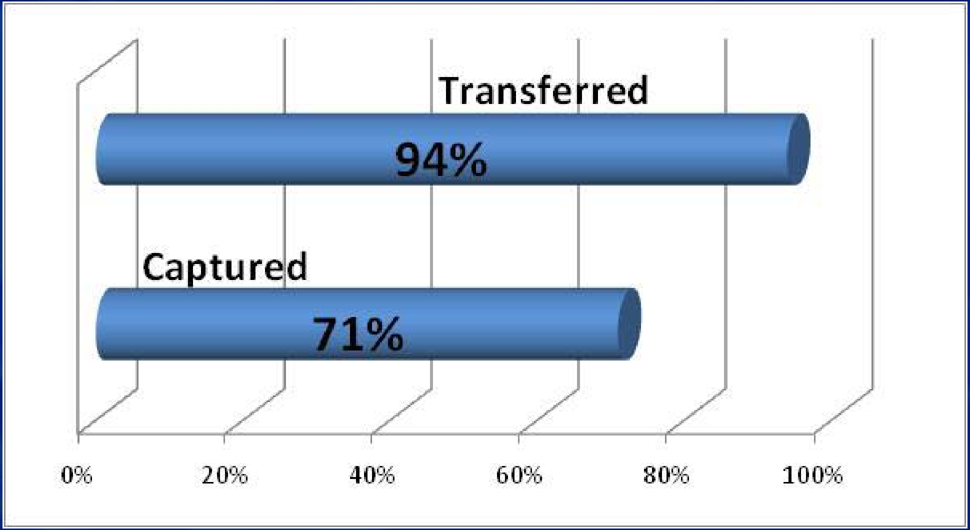
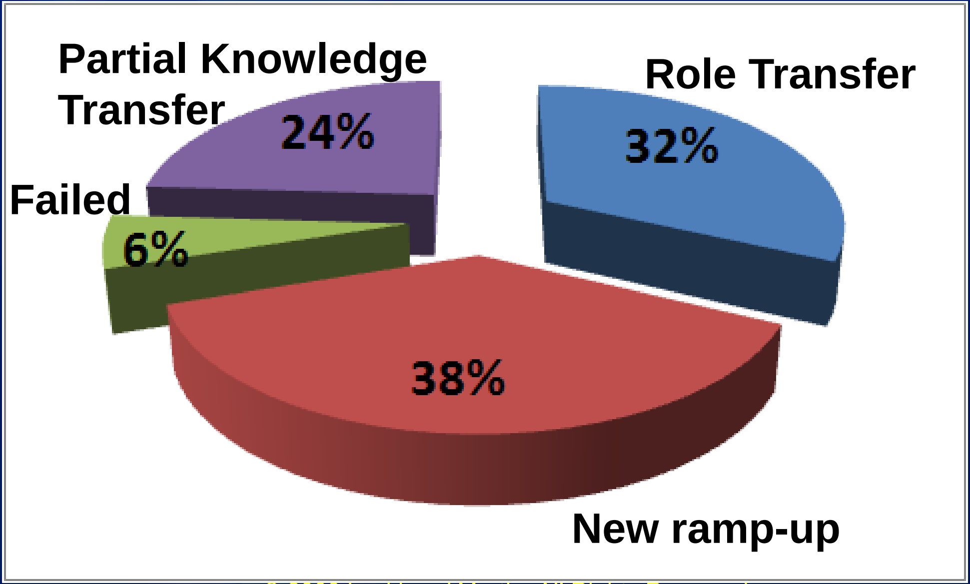
Aggregate of Pilot Team data





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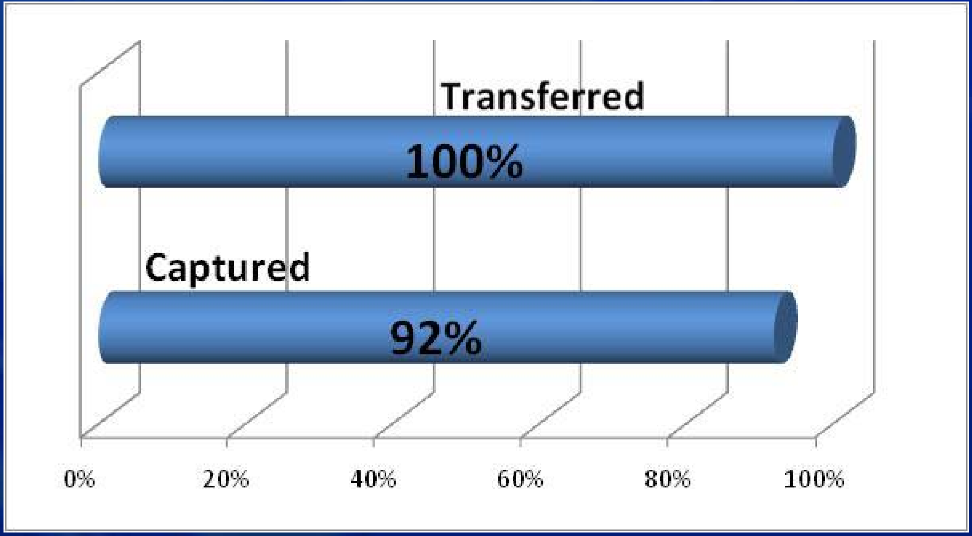
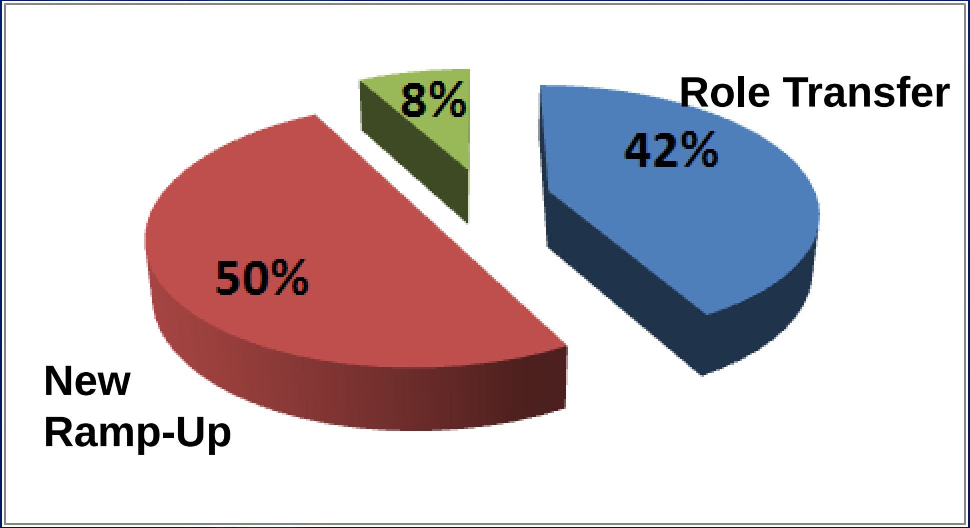
Successful Pilot Teams





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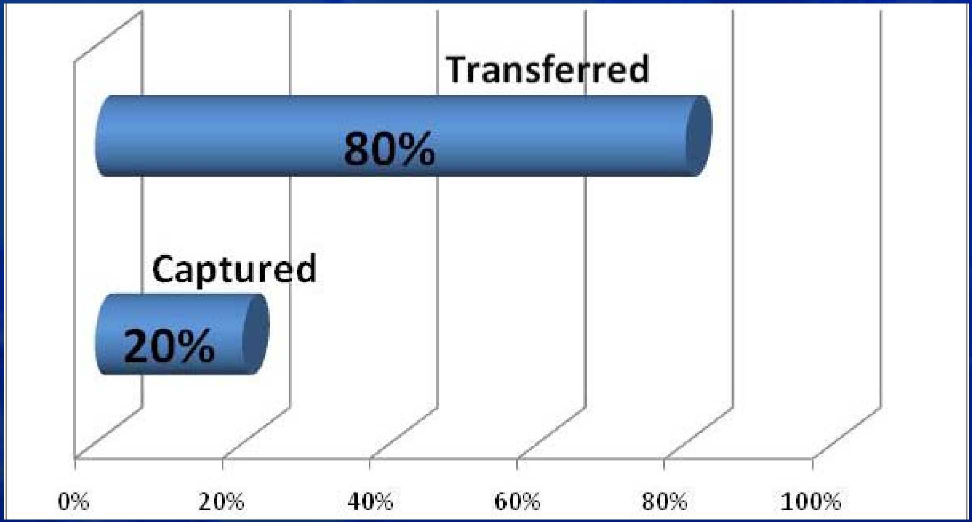
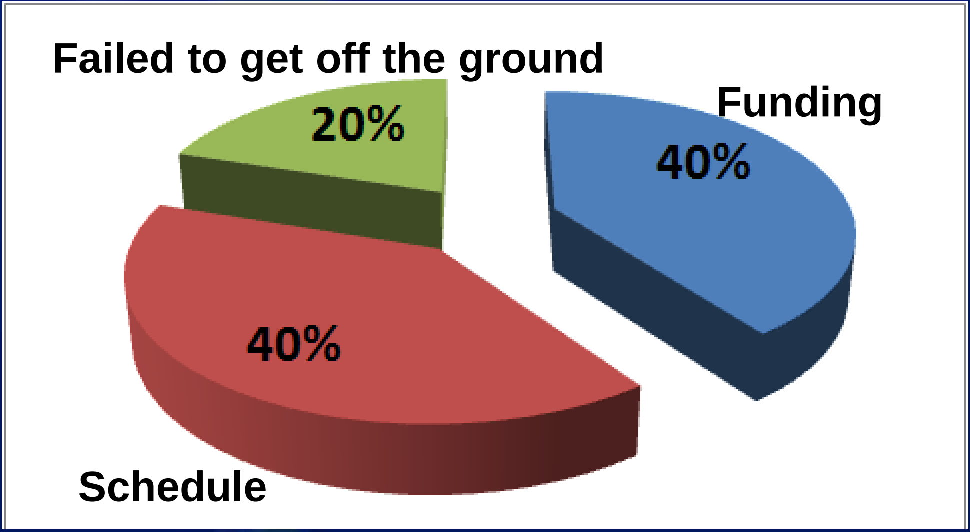
Pilot Teams that Struggled …didn't follow processes





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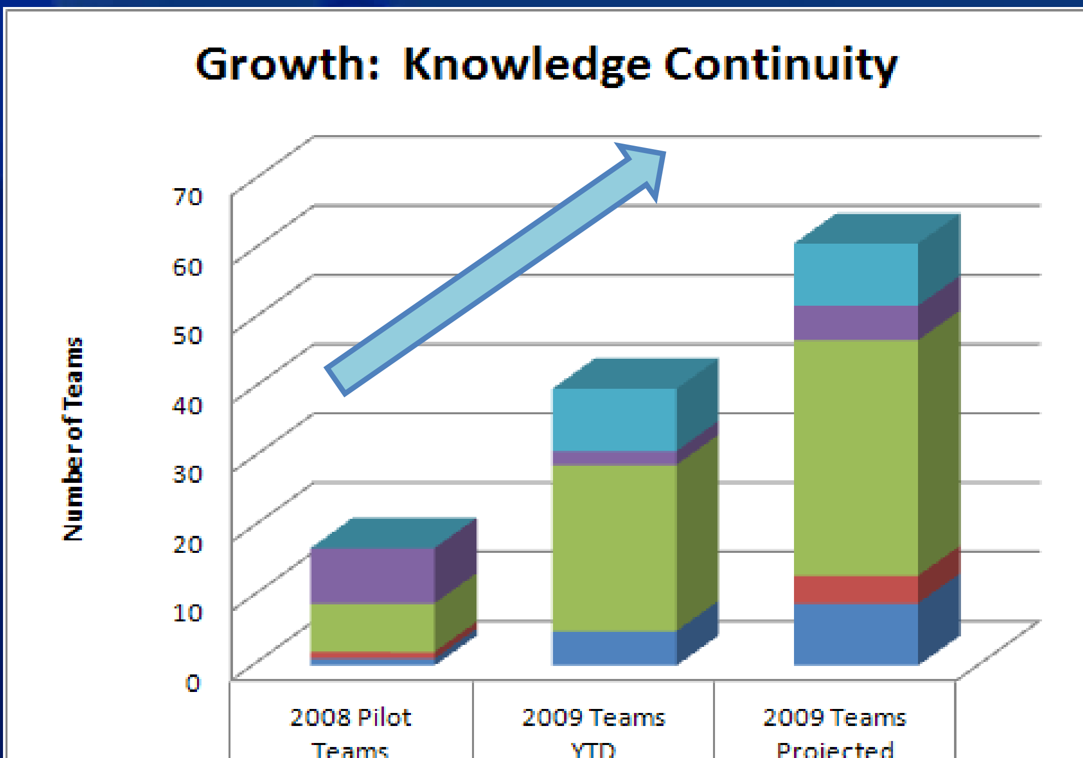
KC Surge (post-Pilot) since 1/1/09

- Across every Business Area in LMC!!
- Growth has mostly been organic



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KC Surge (post-Pilot) since 1/1/09

- KC exists in every Business Area across LMC
  - ~400 individuals, 29 facilitators trained in LMC KC process to-date
  - 56 teams since 2008 have employed KC to capture at-risk knowledge critical to business/programs
  - 135% higher KC participation since 2008 Pilot, will be much larger if expectations are realized
  - KC used on key defense programs to protect critical defense knowledge & LMC Program Performance Management / Earned Value
  - Forbidden

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KC Cases: Stories on Knowledge Continuity Story Telling

Retirement

- Knowledge of mission s/w
- Individual needing the knowledge had 15 yrs experience in flight s/w

KC Process

- 100% of Expert's role was transferred
- Individual needing the knowledge feels "up-to-speed," "more engaged," "gaining expertise"

This SSI KC Pilot team:

- Captured artifacts on classified network
- Knowledge used! Monte Carlo analysis
- Found leadership extremely supportive
- Expended only 60 hours & now has a new Expert up-to-speed

When everyone on a KC Team is Engaged, the KC Process can Plug the Brain Drain, Grow Expertise, & Improve Productivity!

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KC Cases:
Stories on Knowledge Continuity Story Telling

Deployable, Exponential Growth

- Expert close to retirement (32 yrs)
- 3 individuals rec'd expertise
- BA needed skills growth

KC Process

- Two individuals assigned to another BA site
- Remaining individual stayed on program

This SSI KC Pilot team:

- Tailored KC process
- Captured all topics identified on SharePoint folder & Unity
- Expended only 72 hours

At all levels of the KC Team the KC Process can help Exponentially Grow Deployable Knowledge!

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KC Cases:
Stories on Knowledge Continuity Story Telling

Unity Artifacts…Useful Application

- Expert was more junior but had unique expertise
- Others ranged from highly experienced to inexperienced

KC Process

- Developed a template for Unity space for future KC teams
- Newer employees feel “up-to-speed,” “more engaged”

This SSI KC Pilot team:

- Tailored the KC process/artifacts on Unity!
- During KC, worked on collaboration projects
- Saved $ using knowledge transferred to develop Ambassador's Guide

The KC Process is Non-Generational: assisting employees during Ramp-Up & Transition!

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Conclusions

- Successful Knowledge Transfer so that knowledge is pervasive is possible
  - Ease retirements and reduce single points of failure
  - Exponentially grow experts; assure performance
  - Speed ramp up
- Critical to success is piloting processes and techniques to find what works
  - Multi-talented, multi-disciplinary, multi-business team was key
  - Leadership support most critical
  - Recognize expertise as non-generational
  - Less spoon feeding, more empowering and enabling.
  - Make “bubble up” of KC projects as easy and possible as “top down” encouragement
  - Don’t just ask an expert to “share their knowledge” (e.g., ad-hoc mentoring model)
    - Provide techniques and processes to assure success
    - Show them the What’s in it For Me (WIIFM)

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Report on a Study on Management Concepts for Broadly-Needed Modeling and Simulation Tools in the U.S. Department of Defense

NDIA Systems Engineering Conference
San Diego, CA
October 26-29, 2009

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Presentation Outline

- Study Background
- Study Objectives and Approach
- Surveys of M&S Tool Managers and Users
- Categories of Tool Management Approaches
- Taxonomy for Assessing Success of Management Approaches
- Preliminary Assessment of Success Attributes for M&S Tool Management
- Future Work

Management Concepts for Broadly Needed M&S Tools Study Background (1 of 2)

- Certain M&S tools are common to multiple programs and organizations
- Many government-managed models and simulations are already used broadly
- However, such broadly-used M&S tools typically suffer from several problems, including
  - A lack of adequate model manager funding, and
  - A stakeholder requirements management council to:
    - allow the incorporation of tool enhancements developed by users into the standard version ("street version"),
    - improve the model's accuracy by examining discrepancies between the model and actual test results (the "fix" step of the "model-test-fix-model" process), and
    - build in new capabilities to meet foreseeable needs, such that the capabilities can be delivered by the time users need them

Management Concepts for Broadly Needed M&S Tools Study Background (2 of 2)

- **Study is sponsored by the Director, Office of the Director of Systems and Software Engineering (D, SSE) in the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics (OUSD(AT&L))**
  - **On behalf of the Acquisition M&S Working Group (AMSWG)**
- **Study is an <u>initial</u> step in addressing Acquisition M&S Master Plan (AMSMP) Action 3-4 ("Centrally fund and manage the development of high-priority, broadly-needed M&S tools")**
  - **Before embarking on such an initiative, it is prudent to objectively study DoD's current experience in the management of broadly-needed tools**
    - **Attempt to identify innovative approaches that could be leveraged to improve the cost-effectiveness of DoD M&S tools more broadly**

Management Concepts for Broadly Needed M&S Tools Study Objectives

- **Identify best practices for managing broadly-needed M&S tools**
- **Based on these findings, recommend actions the U.S. DoD should take to improve its management of such M&S tools**

Management Concepts for Broadly Needed M&S Tools Study Approach

▪ Develop list of M&S tools used by multiple organizations not under the same chain of command or contract	▪ Done – but still growing
▪ Survey M&S tool managers and users on management approaches	▪ Done – but still accepting inputs
▪ Document and categorize management approaches for the tools identified	▪ Done – but open to update
▪ Assess degree of success each tool management approach has had in avoiding certain problems	▪ Done, based on survey responses
▪ Develop a taxonomy for assessing success of M&S tool management approaches	▪ Taxonomy developed
▪ Identify/develop best practices for managing broadly needed M&S tools	▪ Success attributes developed
▪ Recommend actions DoD should take to improve its management of broadly-needed M&S tools	▪ In progress
▪ Develop list of desirable characteristics of candidate tools to be used in pilot applications	

List of M&S Tools with Responses to Tool Manager Survey (31 responses on 27 tools)

- Advanced Joint Effectiveness Model (AJEM)
- Advanced Testing Capability (ATC)
- Battle Command Management Service (BCMS)
- Comprehensive Mine and Sensor Simulator
- Extended Air Defense Simulation (EADSIM)
- Hazard Prediction and Assessment Capability (HPAC)
- Intelligence Modeling and Simulation for Evaluation
- Joint Analysis System (JAS)
- Joint Conflict and Tactical Simulation (JCATS)
- Joint Communication Simulation System (JCSS)
- Joint Integrated Mission Model (JIMM)
- Joint Semi-Automated Forces (JSAF) (JFCOM version)
- Joint Theater Level Simulation (JTLS)
- Langley Standard Real-Time Simulation in C++ (LaSRS++)
- Model for Intratheater Deployment by Air/Sea (MIDAS)
- Naval Simulation System (NSS)
- One Semi-Automated Forces (OneSAF)
- OpenEaagles Simulation Framework
- ProtoCore
- Role Player Workstation
- RunTime Infrastructure (RTI) - MATREX
- RTI NG Pro
- Simulation Display (SIMDIS)
- SPIRITS
- Suppressor
- Synthetic Theater Operations Research Model (STORM)
- Threat Modeling and Analysis Program (TMAP)

Questions on the M&S Tool User Survey

Responder Information

1) Name 2) Rank/Title 3) Organization 4) Email Address 5) Phone Number

Requirements Management

6) How should user requirements be prioritized when funding and/or schedule are insufficient to meet all requirements?

Configuration Management

7) Is it critical to maintain a single source baseline, or are there circumstances under which multiple forks should be permissible? What criteria should be used to make this decision?
8) Identify good tool distribution mechanisms/methods (for source, executable, or both).
9) How frequent should releases be? Please describe the criteria upon which the frequency may depend, e.g. tool maturity, criticality of bug fixes.

Code Development

10) Should externally developed code (by users or others) be integrated into the code baseline?
11) How should conflicts between modifications submitted by different users/co-developers be mediated?

Test Management

12) Should V&V be a formal part of the integration process?
13) What processes/products are critical prior to product release, e.g., regression testing, reference data?

Lessons Learned

14) Please describe any other management best practices that are critical to successful model management.

Categories of Tool Management Approaches (1 of 2)

- Government Coordinated (GC)
  - A single government office coordinates development of one version of the tool for all users. Government mechanisms, like MIPRs, are used to contribute funds. Developers (contractors or DoD employees) are paid and/or directed through a single coordinator.
- Developer Coordinated (DC)
  - A single development contractor coordinates one version of the tool for all users. Commercial mechanisms, like license fees or development contracts, are used to contribute funds from users.
- Independent Development (ID)
  - One or more developers (contractors or DoD employees) produce their own versions from a common tool baseline. Each user is free to select a version and/or developer.

Categories of Tool Management Approaches (2 of 2)

- Government Open Source Hybrid (GOSH)
  - A government office authorizes certain developers (contractors or DoD employees) to participate in a shared source effort. Each user chooses a developer and all changes are constantly available to all participants.
- Open Source (OS)
  - One or more developers (contractors or DoD employees) participate in a shared source baseline. Each user chooses a version to use. No contractual relationship necessarily exists between users and developers.
- Independent "Co-opetition" (IC)
  - One or more developers (contractors or DoD employees) produce independent changes to a shared baseline. Each user chooses a developer, and the user determines if and when their changes are made available for inclusion in future baselines.

Taxonomy for Judging Success of Approaches – Meeting Foreseeable Needs

- High – manager solicits inputs to future needs; manager prioritizes requirements and integration activities to meet projected user community needs
- Medium – priorities are set by a configuration control board; users may provide additional funding to meet their specific requirements
- Low – projected user community needs are not considered in the requirements and integration process

Taxonomy for Judging Success of Approaches – Integrating User-Developed Enhancements

- **High – manager has structured, documented process for evaluating user enhancements and integrating them into the standard version; process includes regression testing and mediation of differences between submitted changes**
- **Medium – enhancements from a recognized set of sources are accepted and/or the framework allows for users to individually integrate their own plug-ins or libraries**
- **Low – integration of user-developed enhancements is on an ad hoc basis or not at all**

Taxonomy for Judging Success of Approaches – Model Accuracy (Verification and Validation)

- **High – validation or testing of the fully integrated tool is required as part of the structured management process**
- **Medium – manager accepts validation data where available, but does not require it**
- **Low – management process does not include V&V**

Taxonomy for Judging Success of Approaches – Customer Support

- **High – manager provides broad and responsive customer support including live support (help desk) and extensive documentation that supports understanding and use of the model; manager actively communicates with user community**
- **Medium – manager provides documentation beyond just technical/user's manual and live support**
- **Low – manager provides technical/user's manual; live support is on an ad hoc basis**

M&S Tool Management Success Attributes (1 of 3)

M&S Tool Management Success Attributes: "The M&S Tool Manager …"	**Meeting Foreseeable Needs**	**Integrating User-Developed Enhancements**	**Model Accuracy (V&V)**	**Customer Support**
1. Successfully solicits recommendations from users for new capabilities.	X			
2. Has a process for managing the tool baseline(s) that prevents irreconcilable divergence.	X	X		
3. Has implemented into the baseline tool enhancements agreed upon by a peer / user review process.	X	X		
4. Provides / publishes justification for not including any suggested tool enhancements that were not included in the new baseline tool.	X	X		X
5. Actively communicates with, and engages, users / external developers on a consistent basis concerning tool efficacy and applicability.	X			X

M&S Tool Management Success Attributes (2 of 3)

M&S Tool Management Success Attributes: "The M&S Tool Manager …"	**Meeting Foreseeable Needs**	**Integrating User-Developed Enhancements**	**Model Accuracy (V&V)**	**Customer Support**
6. Has implemented a process to acquire and assess (using a peer / user review process) externally developed capabilities for inclusion into the baseline tool.		X		
7. Publishes a coding standards and style guide with which all externally developed capabilities are required to comply.		X		X
8. Has developed and implemented a quality assurance process that rigorously evaluates each new baseline tool implementation before final product release.			X	
9. Receives and expends the funds necessary to conduct verification and validation tests on all new enhancements, and thorough regression tests on all new baseline releases to ensure past functionality has not been compromised.			X	

M&S Tool Management Success Attributes (3 of 3)

M&S Tool Management Success Attributes: "The M&S Tool Manager …"	Meeting Foreseeable Needs	Integrating User-Developed Enhancements	Model Accuracy (V&V)	Customer Support
10. Updates the User's Guide and / or Technical Reference Manual with each baseline enhancement release, including constraints and limitations.			X	X
11. Receives consistent and adequate funding to conduct tool baseline maintenance, exclusive of baseline enhancements, to ensure the tool remains compatible with current software and hardware products used within the M&S community.				X
12. Provides timely customer support upon receiving a request for assistance (i.e., a competent and adequately staffed Help Desk).				X

Future Work

- Develop preliminary set of recommended actions DoD should take to improve its management of broadly-needed M&S tools
- Share M&S tool management success attributes and preliminary set of recommended actions with tool managers participating in the survey, and other selected members of the DoD M&S community
- Update recommendations based on comments
- Develop list of desirable characteristics of candidate tools to be used in pilot applications
- Produce final report (now targeted for February 2010)

How You Can Still Participate

- **If you are a government or industry manager of a broadly used M&S tool, please complete the survey at**

  http://outersurveyor.outer.jhuapl.edu/ss/wsb.dll/s/6gd

  - **Survey should take 10-15 minutes to complete**

- **If you have prior experience in managing or using M&S tools and have insights on best practices in M&S tool management, please complete the M&S tool user survey at**

  http://outersurveyor.outer.jhuapl.edu/ss/wsb.dll/s/6ge

  - **Survey is similar to manager survey, but not tool-specific**

Live, Virtual, Constructive Architecture Roadmap: The Quest for Interoperability, Standards, and Reuse

Gary W Allen, PhD
Project Manager
JTIEC
&
Amy Henninger, PhD
Associate Director
M&SCO

Presentation Agenda

- Introduction
- Where are we?
- How did we get here?
- Where are we going?
- How are we getting there?
- Why are we doing this?
- Conclusion

Where are we?

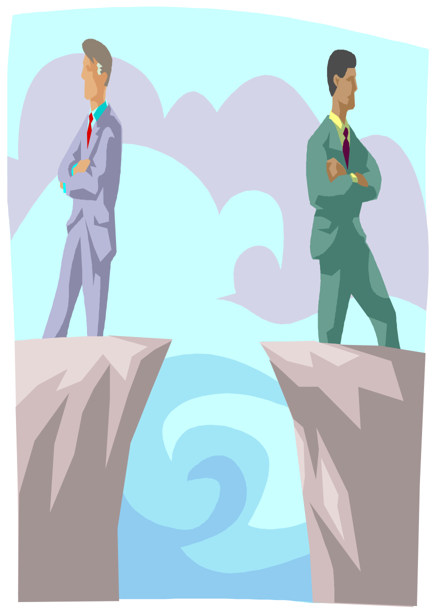
- LVCAR Study Completed SEP 2008
- Provided:
  - Recommendations
  - Rationale
  - Business Models
- Phase II:
  - LVCAR Implementation
  - Two year effort
  - Take advantage quick starts
  - Involve the entire M&S community
  - Provide exit strategy

How did we get here?

Growing Demand For
LVC Interoperability
Technical & Joint Operations

Broad Proliferation of
Tools, Standards, Gateways
Repositories, etc

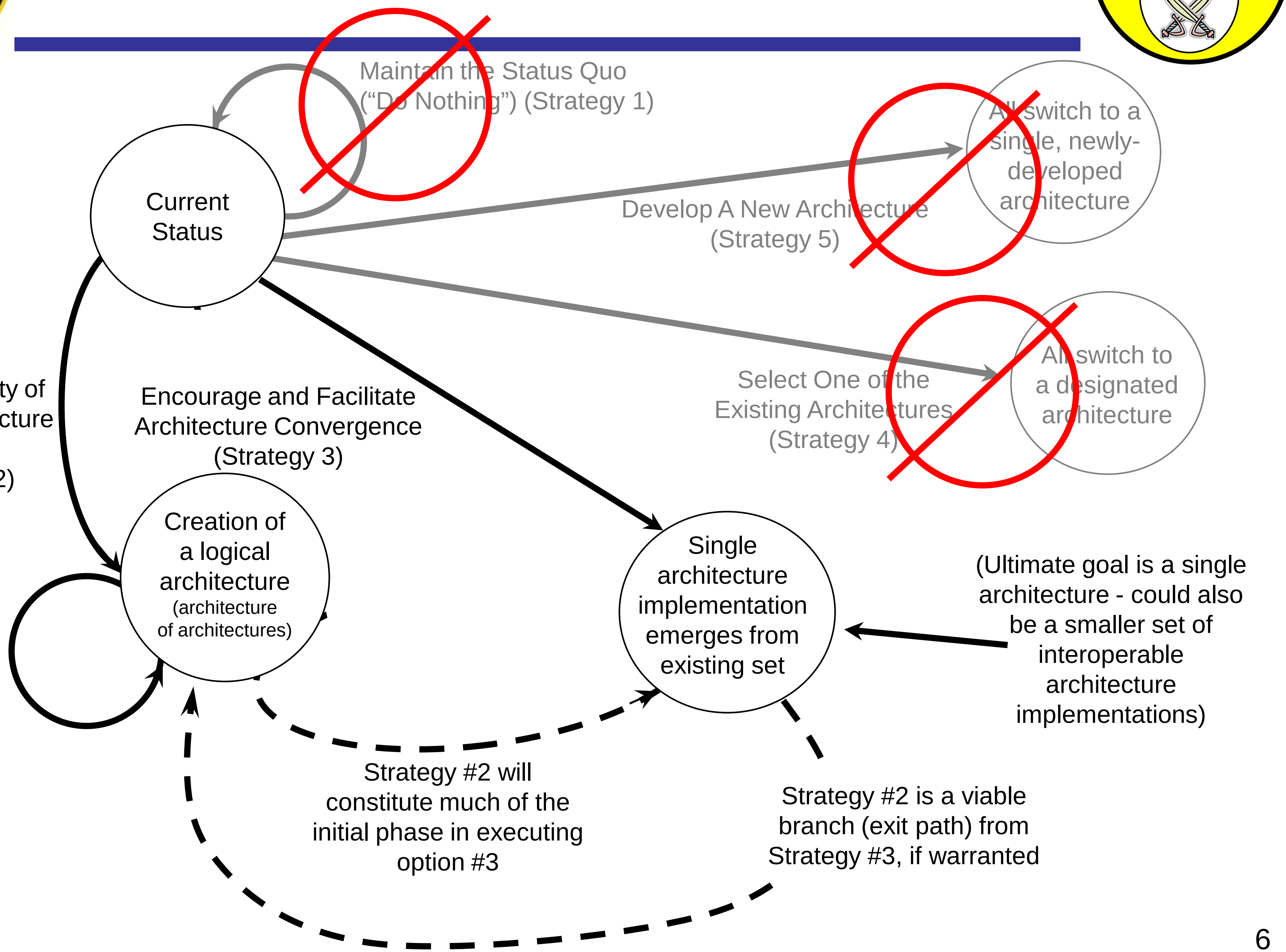
Numerous, Parallel
Architectures
(HLA, DIS, CTIA, TENA)



How did we get here?

- Live, Virtual, Constructive Architecture Roadmap (LVCAR) Study
- Purpose: “Develop a future vision and supporting strategy for achieving significant interoperability improvements in LVC simulation environments.”
- Focus: Three dimensions of simulation interoperability
  - Technical Architecture
  - Business Models
  - Standards Evolution and Management Process
- Precepts That Guide Implementation
  - Do no harm
  - Interoperability is not free
  - Start with small steps
  - Provide central management
- Result: A set of recommendations that guide HLT S-C-2

How did we get here?



Where are we going?

Focus: Pursue recommendations identified in the Live, Virtual, Constructive Architecture Roadmap (LVCAR) report sponsored by the OSD Modeling & Simulation Steering Committee (M&SSC)

		Investments	*Initial Investment*	*Bounds of 10-year Investment*	*Coordinated by*
Architecture Activities	1	Common components of architecture-independent object models	5 MY	5 - 20 MY	RET
	1	Describe and document a common, architecture-independent systems engineering process	2.1 MY	2.1 - 9.6 MY	RET
	1	Create common, reusable federation agreement template	1.7 MY	1.7 - 7.7 MY	RET
	2	Analyze, plan and implement improvements to the processes and infrastructure supporting M&S asset reuse	1.8 MY	7.7 MY	MSSC and RET
	2	Produce and/or enable reusable development tools	3.8 MY	3.8 – 15.8 MY	RET
	1	RRI – Convergence feasibility determination and design	7 MY	N/A	TAT
	3	Convergence plan	.8 MY	.8 - 3.7 MY	RET
	3	Convergence implementation	RRI dependent	RRI dependent	RET
	1	Produce common gateways and bridges	4.25 MY	4.25 - 17 MY	RET
	2	Specify a resource or capability to facilitate pre-integration systems readiness	5.2 MY	5.2 - 21.7 MY	RET
Standards Activities	2	Make IEEE standards more accessible to LVC community.	50K – 150K	N/A	MSSC
	1	Engage SISO and the broader LVC community	1 MY, $200K	10 MY, $2M	MSSC
	2	Coordinate activities and fund participation in commercial standards development groups	2 MY	20 MY	MSSC
	1	RRI - Increase sphere of influence in SISO	1 MY	N/A	MSSC
	1	Develop evolutionary growth path for LVC standards	1 MY	N/A	MSSC
Business Activities	1	Identify LVC Keystone	TBD	TBD	MSSC
	1	RRI – Balance the marketplace	1 MY	N/A	TAT
	3	Balance the marketplace	RRI dependent	RRI dependent	MSSC
Management Activities	1	Decision Support Data	1 MY	10 MY	MSSC

TASK	ACTIVITY
1	Arch-Independent Object
2	Common Capabilities (Reuse)
3	Architecture Convergence
4	Bridges & Gateways
5	Management & Standards

Where are we going?

- **Approach**
  - **Reduce** LVC architecture divergence and tool proliferation
  - **Identify** organizational and structural (e.g. use of standards) options to better manage LVC architecture interoperability
  - **Create** reference models to focus data and service reuse efforts
  - **Explore** emerging technology issues related to future LVC architecture performance and requirements

Where are we going?

- **Desired Results**
  - **Standardized** bridges and gateways to link architectures
  - **Convergence** of LVC architecture activities and reuse libraries
  - **Commonality** in federation templates, object models, engineering processes
  - **Initiatives** to pursue translational architectures

How are we getting there?

M & S SC

LVCAR Study

Identifies Areas of Investment

(FY09 Phase 1)

IMPLIMENT LVCAR

MANAGING THE LVC ENVIRONMENT

CONVERGE THE LCV ARCH

COMMON LVC CAPABILITIES

COMMON LVC GATEWAYS & BRIDGES

ARCH IND OBJECT MODEL

(FY10 Phase 2)

LVCAR CORE ARCHITECTURE

Tool Box
Arch Ind Data Formats
Library/Depository
Dev Tools
LVC Capabilities
STD Gateways
STD Bridges

Net-Centric
- SOA
- Sim Interface

(FY11 Phase 3)

LVCAR Exit Strategy

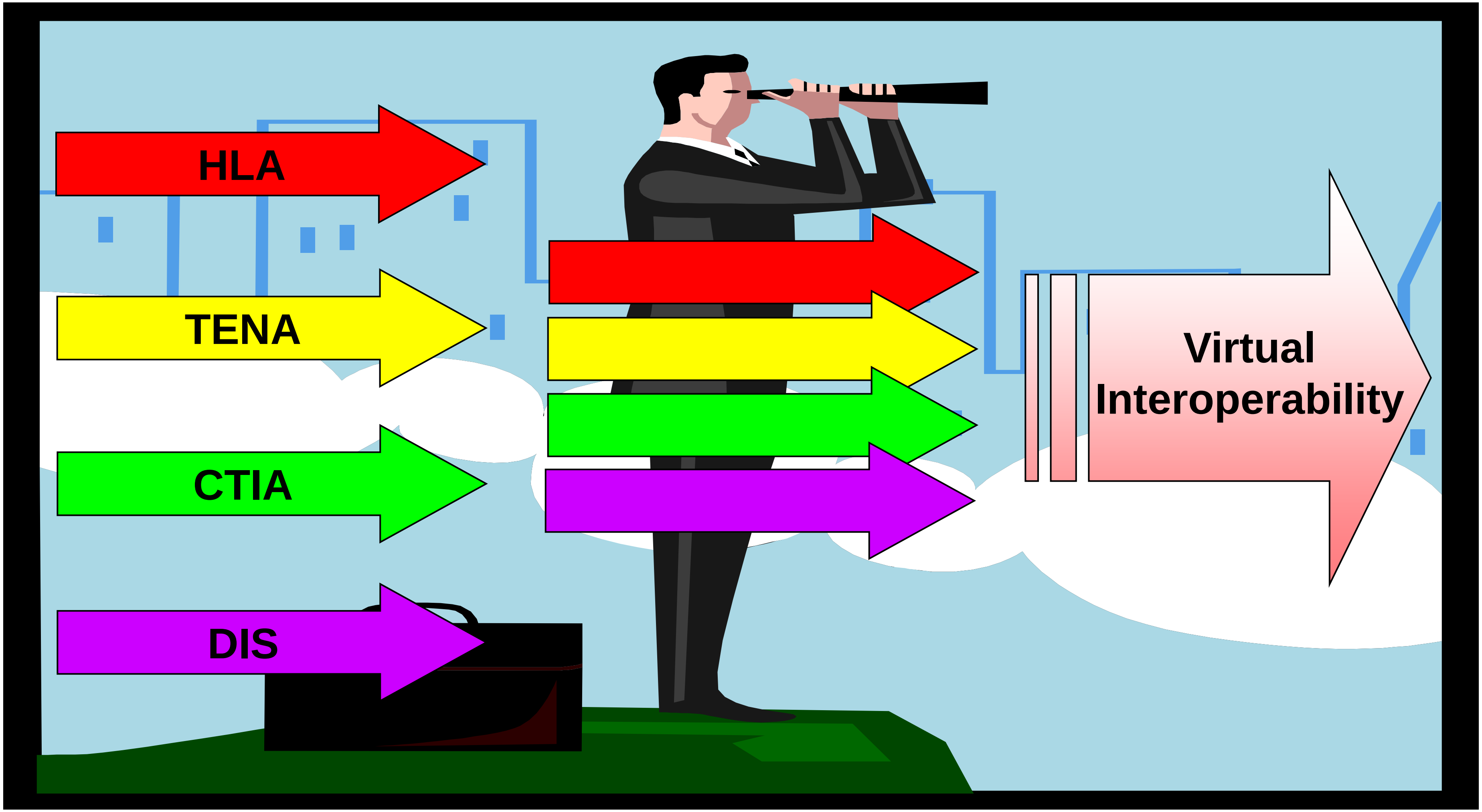
- Business Models
- Policies
- Standards
- Utilities

(FY12)

M & S COMMUNITY

Why are we doing this?

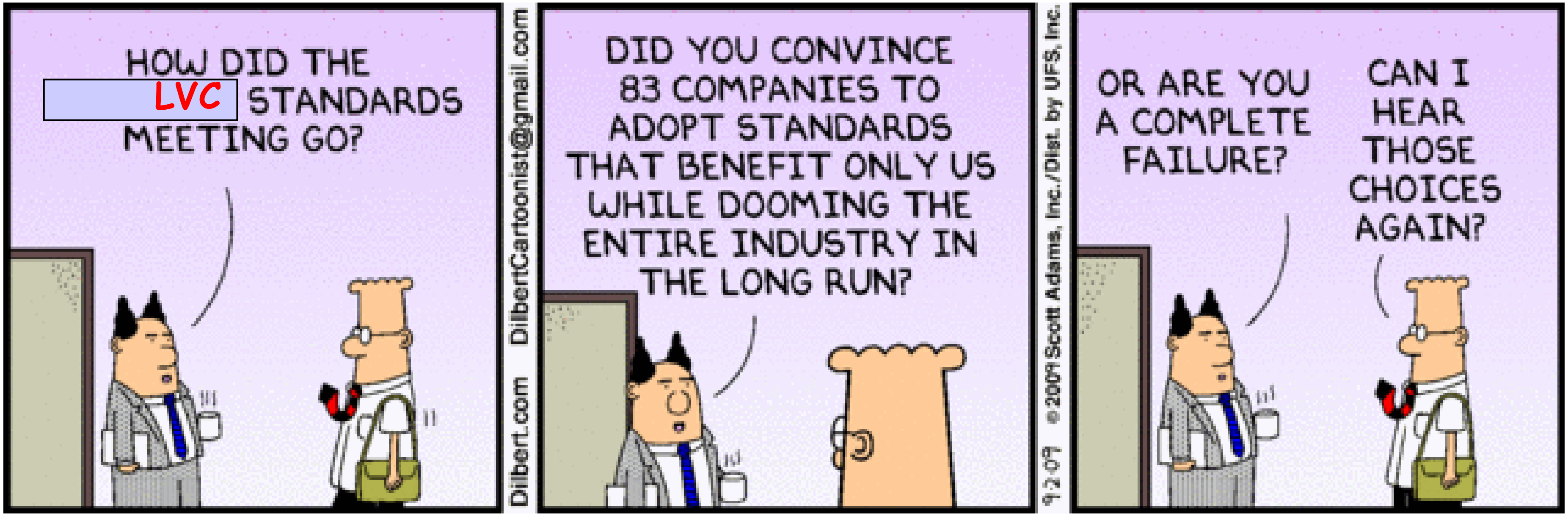
Why are we doing this?



Summary

- JTIEC and M&S CO have established a productive and collaborative working relationship
- Currently S-C-2 HLT has no major performance, schedule or cost issues
- S-C-2 Project Manager focus is to carry forward the recommendations from the defining LVC Architecture Roadmap study to the ultimate benefit of the readiness of our warfighters.

Discussion



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Systems Engineering Approach to Workforce Development

29 Oct 09

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Systems Engineering Definition

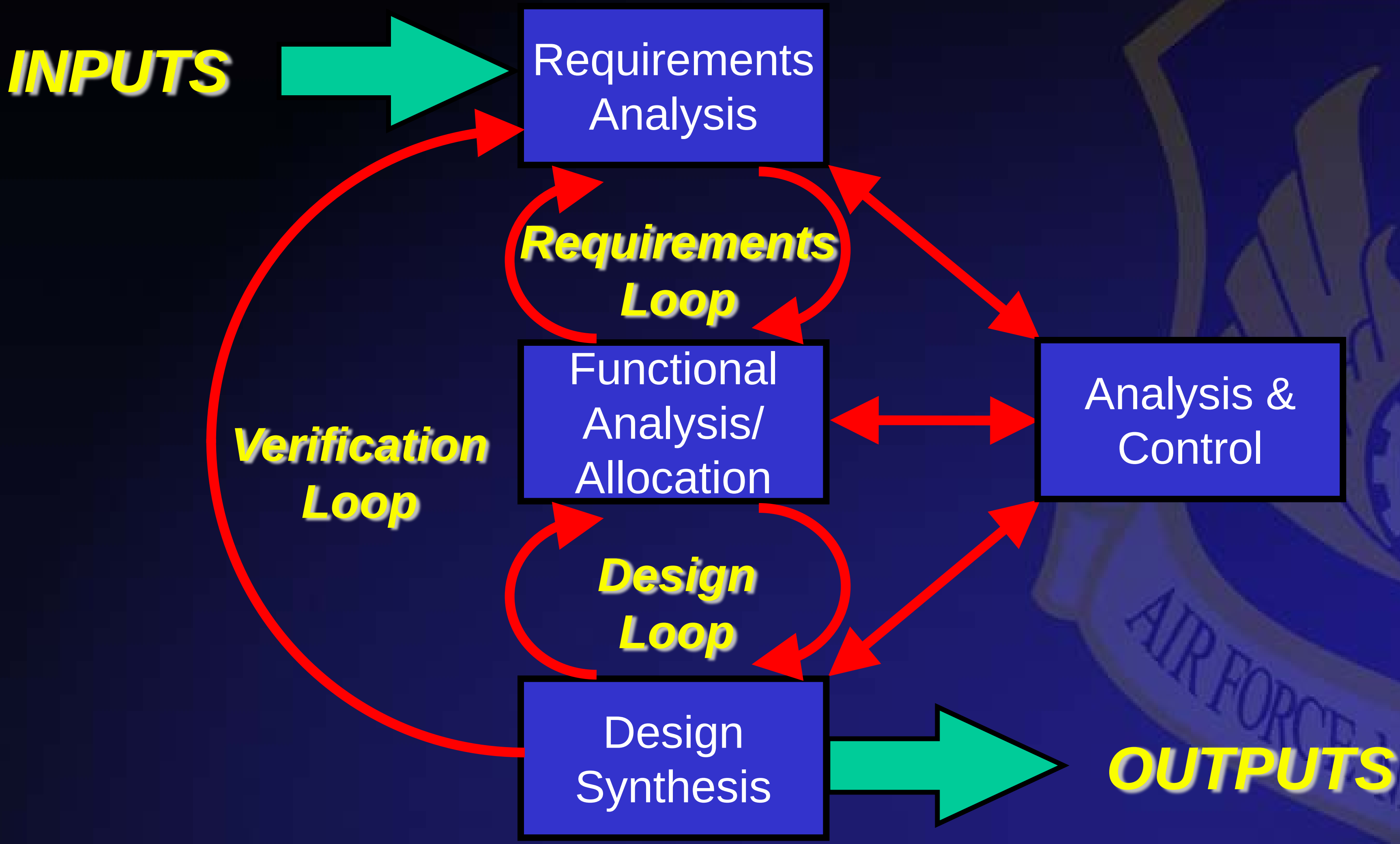
- Systems engineering can be thought of as the problem-independent principles and methods related to the successful engineering of systems.
- DOD Definition: SE is an interdisciplinary approach encompassing the entire technical effort to evolve and verify an integrated and total life cycle balanced set of system, people, and process solutions that satisfy customer needs.
- INCOSE Definition: Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems…Systems Engineering integrates all the disciplines and specialty groups into a team effort forming a structured development process that proceeds from concept to production to operation.

So What?

- The workforce is certainly “problem independent”, a “method”, a “means” and “related to successful engineering”
- By any account, an organization’s engineering workforce is one of the keys to successful systems engineering.
- Rather than the usual ad hoc, target-of-opportunity approach, an organization can apply a disciplined, methodical *<u>systems engineering</u>* approach to successfully develop the engineering workforce.

327th Aircraft Sustainment Wing Responsibilities

Basic Systems Engineering Process



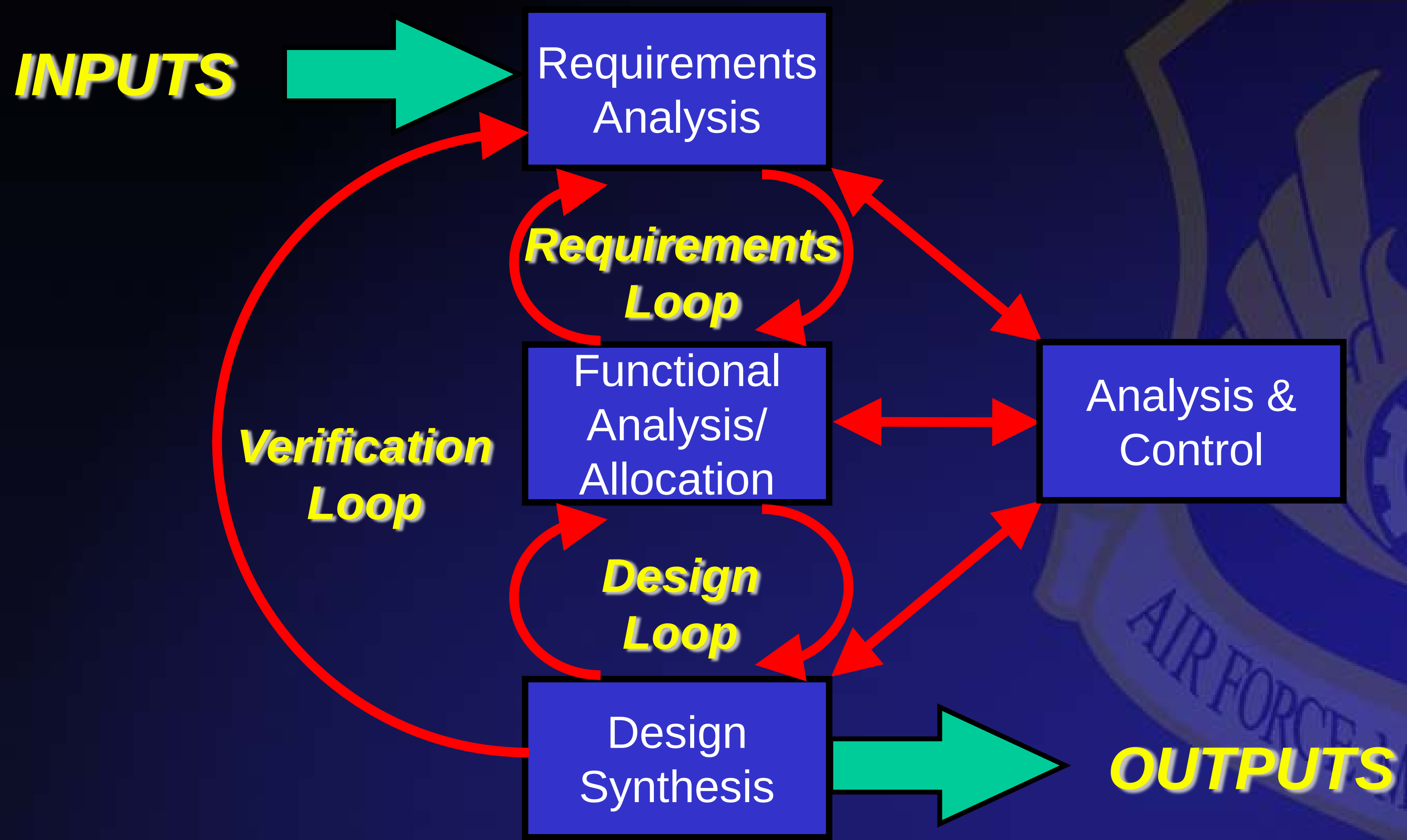
Input

- 334 Engineers in the 327 ASW
- Scattered across:
  - 6 different organizational groups
  - 19 different squadron/supervisors
  - 30 different weapon systems
- Composed of:
  - 6 different engineering disciplines
  - 46 various years of experience
  - 0 standardized, comprehensive development plans

Requirements

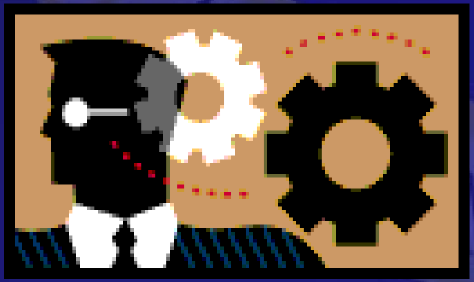
- **Develop the 327 Aircraft Sustainment Wing's Engineering Workforce**
  - **All Inclusive………all engineers**
  - **Standardized……..consistent throughout org.'s**
  - **Comprehensive….covers all tenets of development**
  - **Individualized…….allows for individual needs**
  - **Repeatable………..new employees, each year**
  - **Measureable…...….for mngt & improvement**

Basic Systems Engineering Process

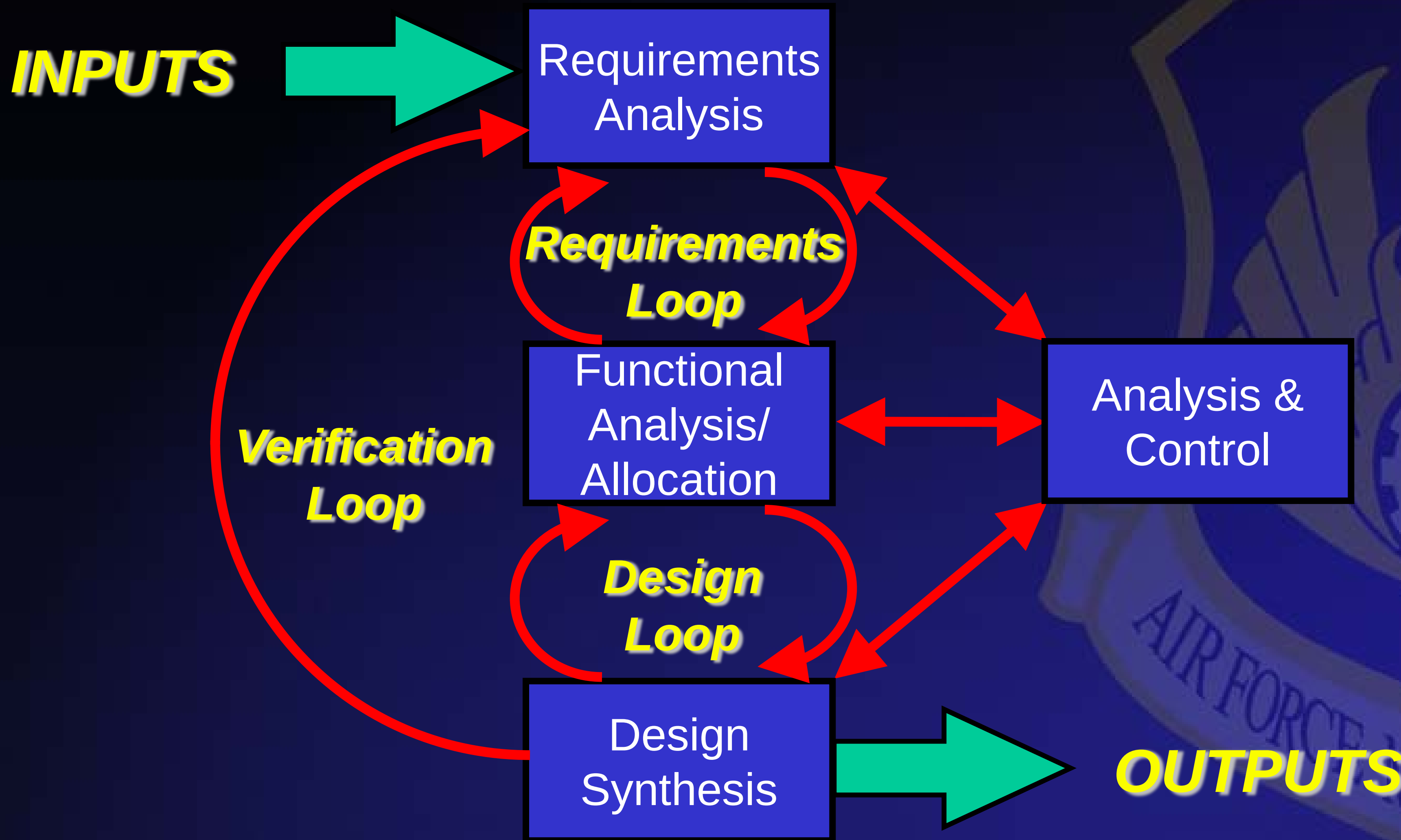


Functional Analysis

- Needed to breakdown what is meant by "Workforce Development"
  - Used the Requirements Loop process
  - Determined the components are:
    - Education
    - Professional Military Education (PME)
    - Acquisition Professional Development Program (APDP)
    - Career Broadening
    - Promotions
    - Awards
    - Training

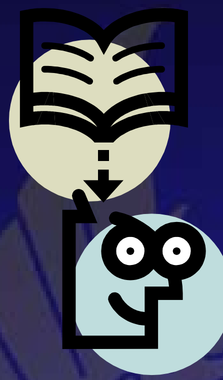


Basic Systems Engineering Process



Design Loop

- Recognized some systems exist
  - Did not cover all 7 components
  - Often not current
  - Difficult to use
- Needed simple means, to look at all components and whole org together
  - Spreadsheet (62 x 354)
  - Cumbersome, but will improve later…
- Horizontal for individual
- Vertical for organization



Design: Personal Data

Name	Series	AFSC	Group	Squadron

- **Allows sorting by name and org**
- **Allows usage by supervisors**
- **Because all data is in one spot, very easy for employee and supervisor to verify data**

Design: Education Data

Have Masters?	Degree type	In Work	No

- Everyone is in one of three categories: yes, no, in-work (because can take almost 2 years to complete and DP systems do not show "in-work")
- Degree Type filled only if "yes" or "in work"
- Post-degree work does not indicate currency

Design: PME

BDE (SOS)	PME IDE (ACSC)	SDE (AWC)	In Work	None

- Everyone is in one of three categories: yes, no, in-work (because can take almost 2 years to complete and DP systems do not show "in-work")
- Recently big push to have
- Employee should pursue "grade appropriate" PME level

Design: APDP

Level I	APDP Level II	Level III	Acq Psn Career Level Rqd	APDP Cert Current

- Several key issues:
  - Do they have an APDP Certification
  - Are they in an Acq Coded job and what level?
  - Is employee current ?
  - Are they ready for "next level"?
- Interesting note: found huge organizational gaps when compared
  - Ex: org A at 95% acq coded, while org B is 34%

Design: Awards

Awards FY09	FY10	FY11

- **“Awards and Recognition” always cited in surveys as a top 3 problem area**
- **Unfortunately, tough to keep up with**
  - **Information has to be updated by awards monitors manually**
  - **Labor intensive effort**
  - **Looking for org trend**

Design: Career Broadening

Career Broadening Done?	When?	Date Arrived in Current Job?	Employee Promoted?

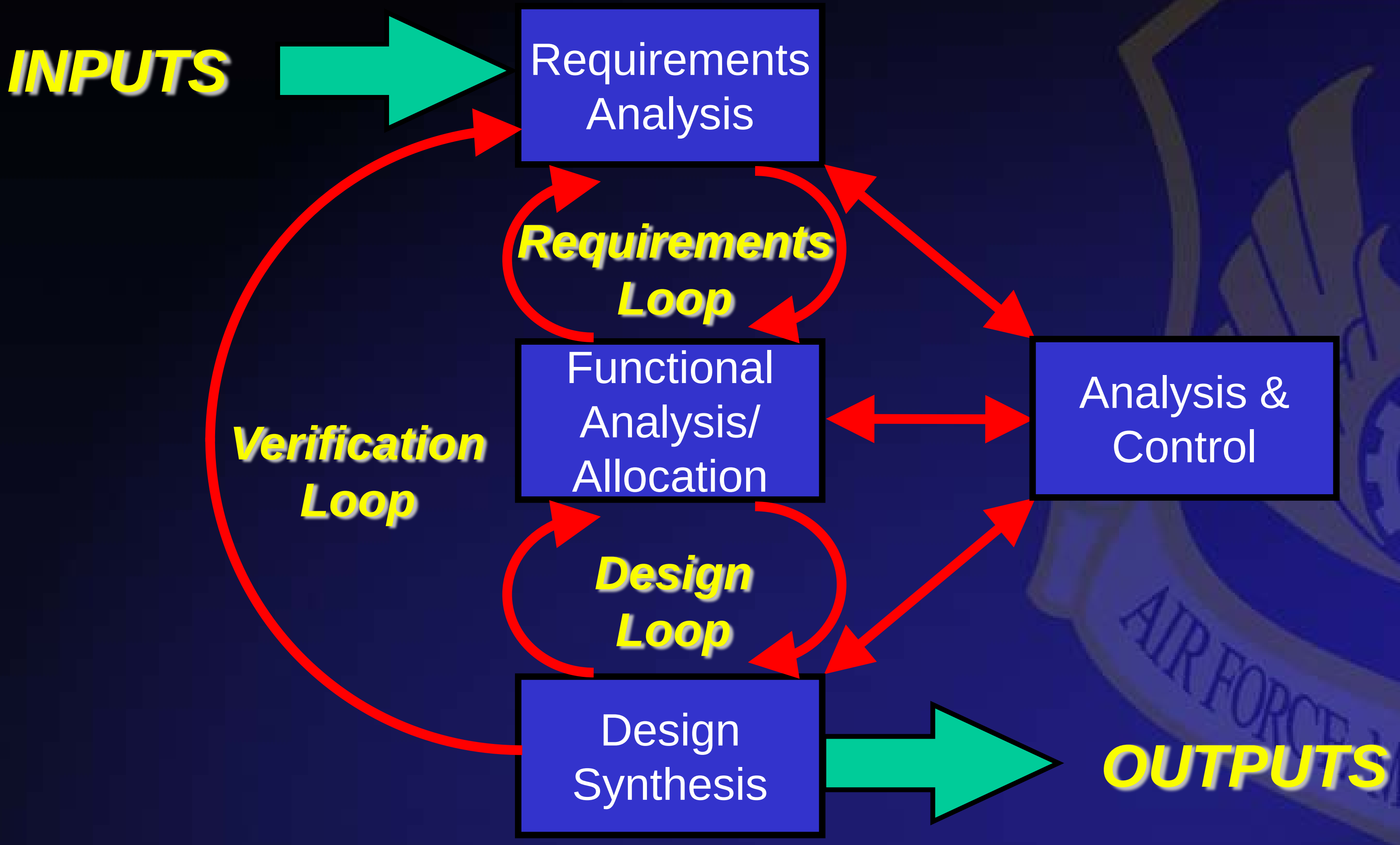
- **Chief Engineer decides if Career Broadening vs just a move**
- **Date Arrived in Current Job is color indexed (cell is filled)**
  - **Green if <3 years**
  - **Yellow if >3 years but <5 years**
  - **Red if >5 years**
- **Promotions tracked separately**

Design: Continuous Learning

Year 1 Courses				Year 2 Courses				Year 3 Courses				Year 4 Courses			
SYS 182	SYS 155	SYS 028	SYS 165	SYS 172	SYS 116	CLE003	CLE009	SYS 161	SYS 138	SYS 185	CLC041	FPM101	CLE011		

- 16 courses
- 4 per year
- All CBT so no travel expenses
  - Minimize time away from job
- Once 16 completed, individualized training/specialization starts

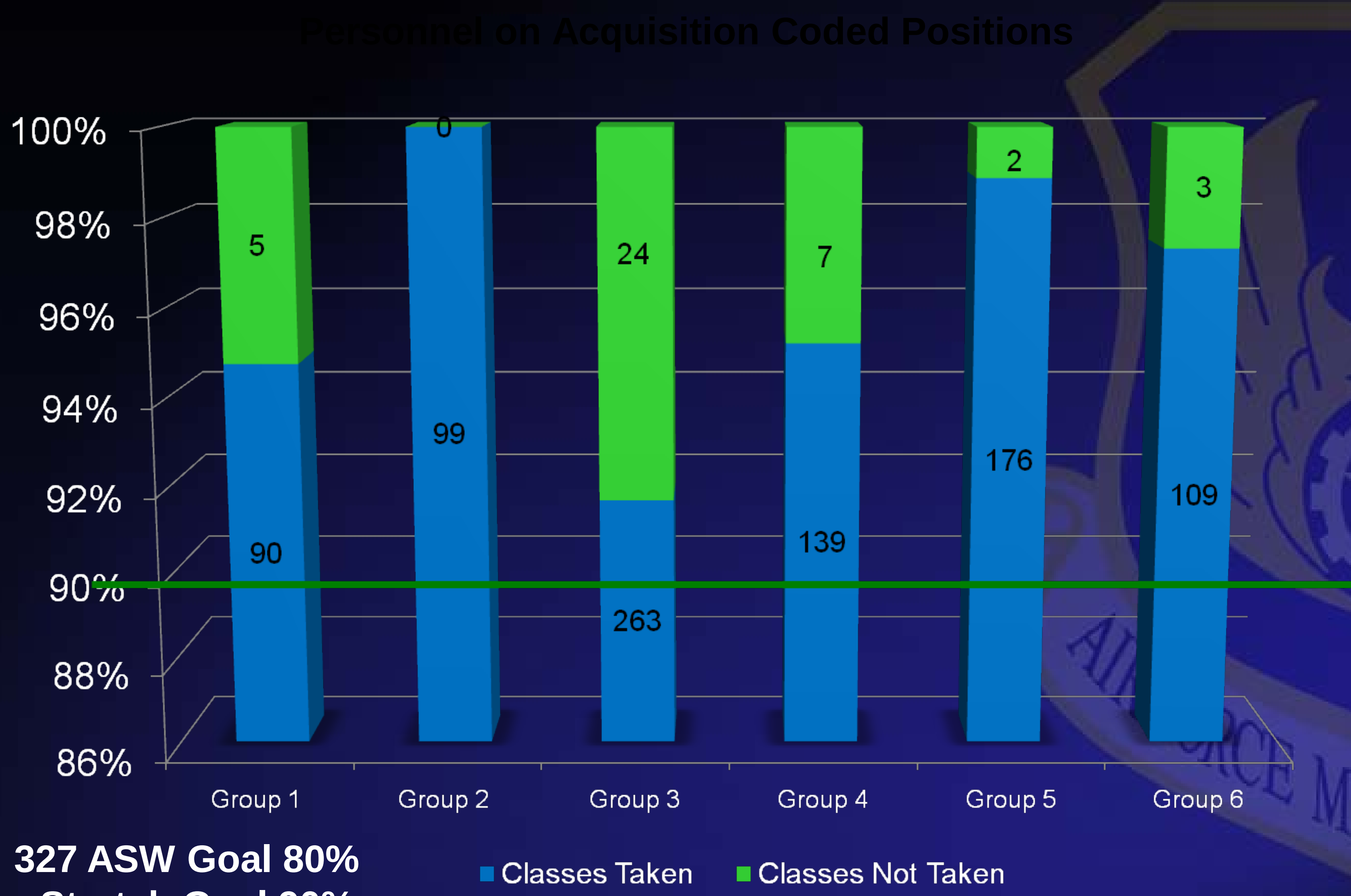
Basic Systems Engineering Process



Analysis and Control

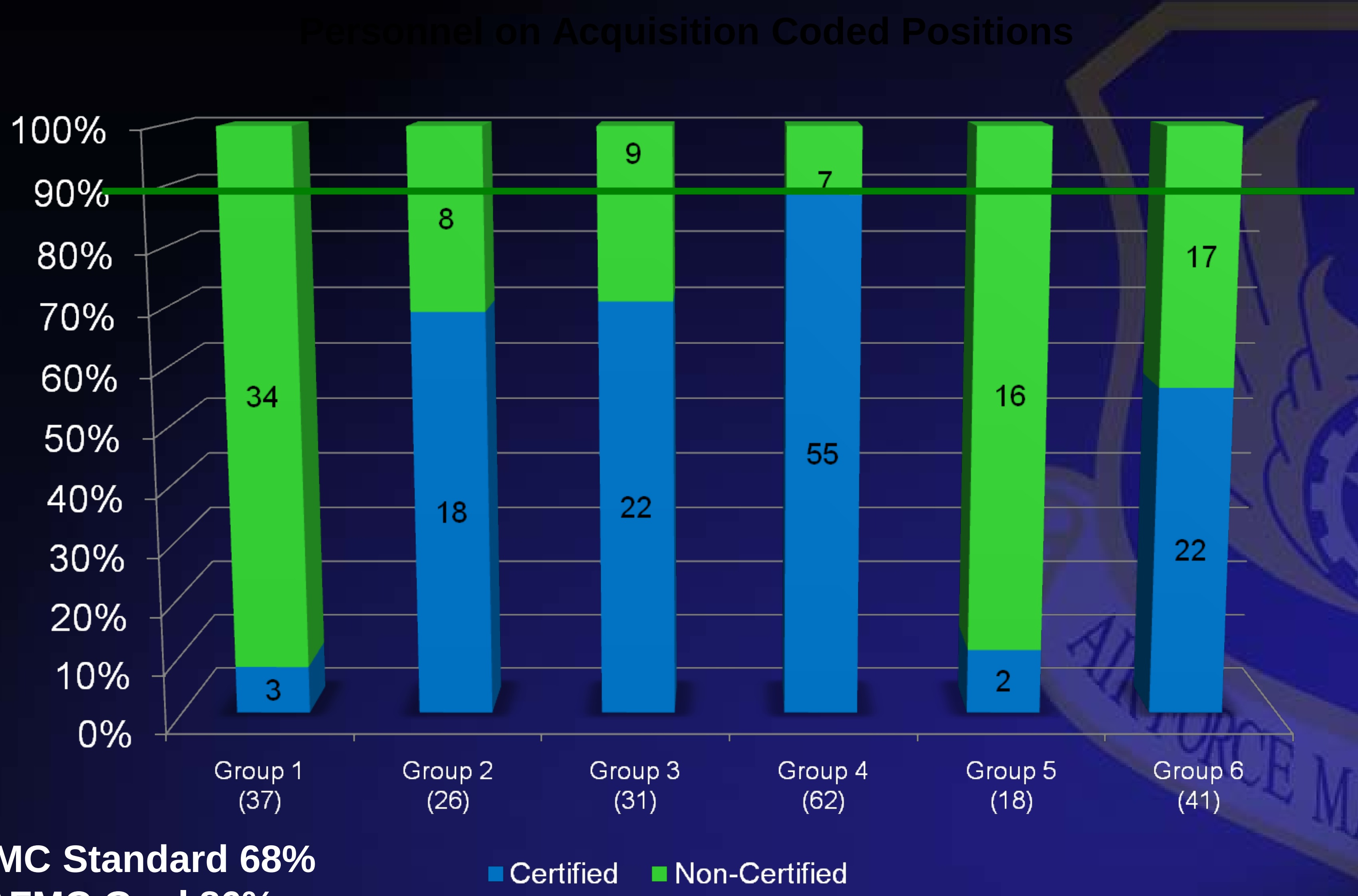
- Several methods used for analysis and control:
  - Annual meeting to standardize/adjust entire program
  - Metrics for each all 7 components
  - Metrics for years to track trends
  - Metrics to compare organizations
  - Tool to be used by supervisor twice a year with employee
  - Metrics displayed to upper management at least quarterly

Control Metric: 327ASW Training



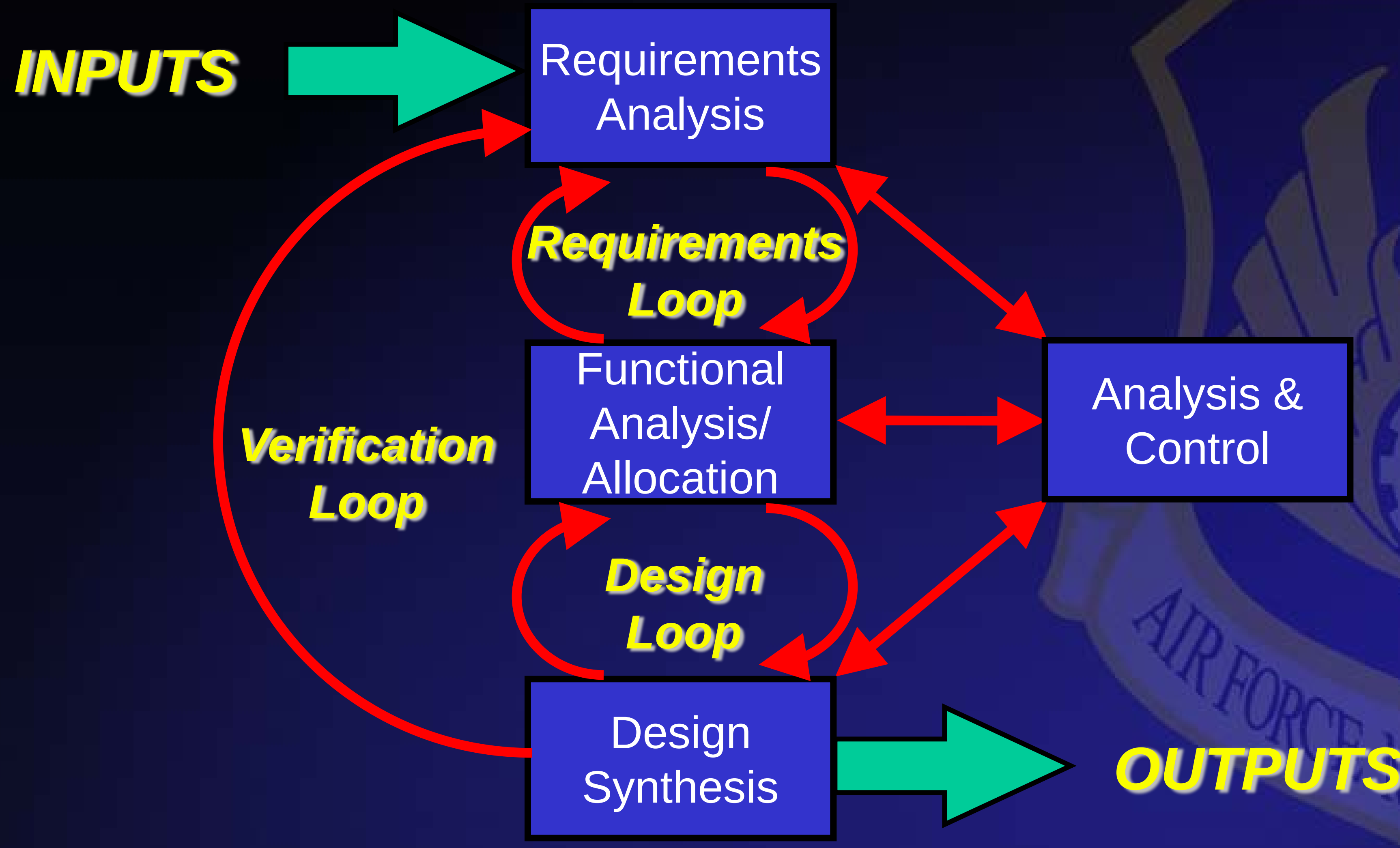
327 ASW Goal 80%
Stretch Goal 90%

Control Metric: Acq Certifications



AFMC Standard 68%
AFMC Goal 86%

Basic Systems Engineering Process



Outputs

- A trained, developed Workforce
- Workforce Development Plan provides:
  - Individualized attention
  - Standard baseline
  - Comprehensive look
  - Repeatable process
  - Measureable data
  - Monitored by upper management
- Example: ASW achieved 96% training goals for FY09

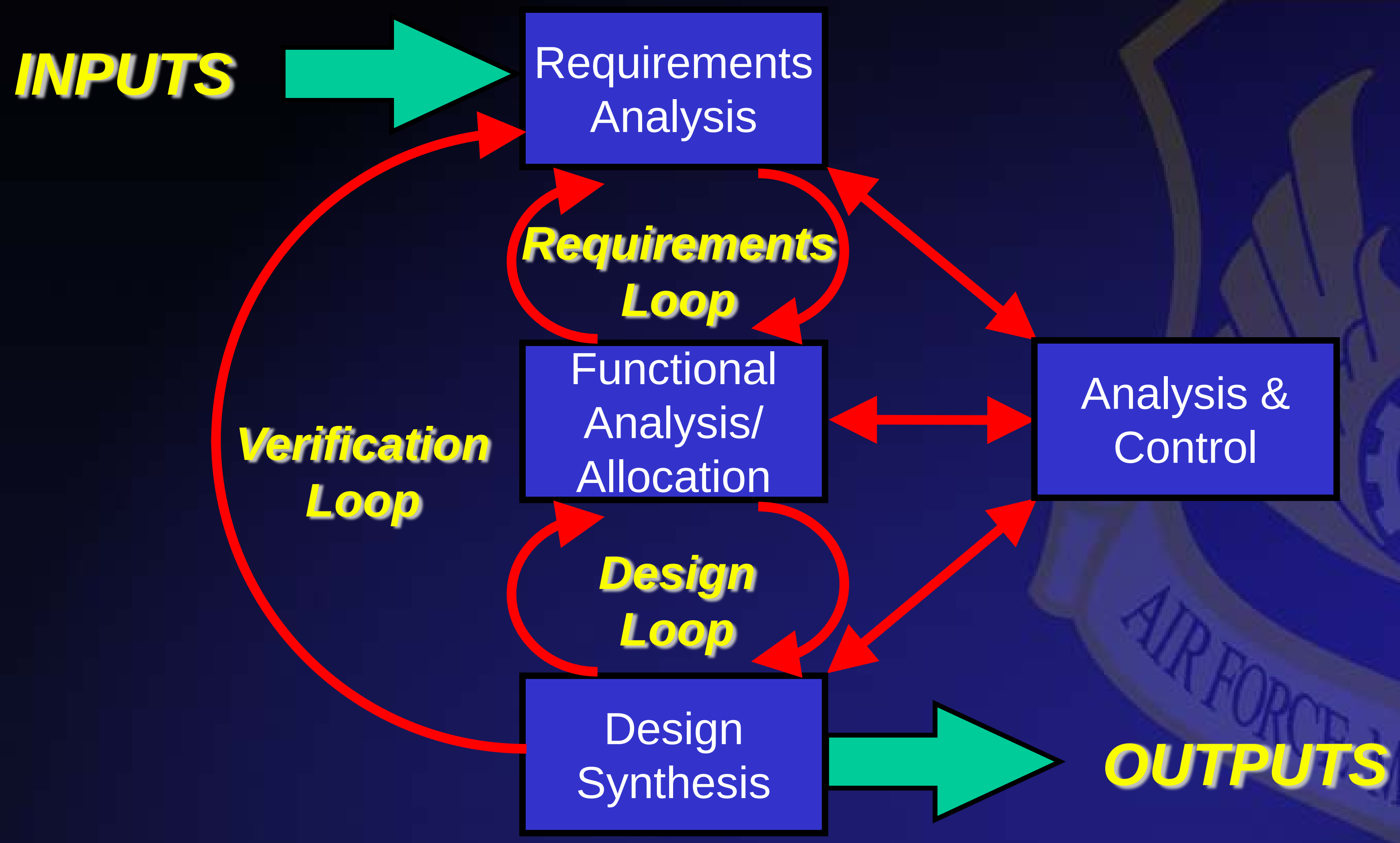
Summary

- 327 ASW developed tangible systems engineering process/plan to develop the engineering workforce
- Clear-cut, tangible process
  - Will apply to 1300 ALC engineers in FY10
  - Plans to use for other disciplines (PM, loggies, etc…)
- Metrics to measure progress for management
- It works!

In Place and In Use Now

Questions?

Basic Systems Engineering Process



Software Assurance in a System of Systems World: Interoperability Challenges – Reports from the Field

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October 2009

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Essential Characteristics of Systems of Systems

Maier's Characterization of Systems of Systems

Autonomous constituents with independent operations and management

- Includes people, organizations, software agents, etc.
- Source of independent actions and decisions

Evolution…

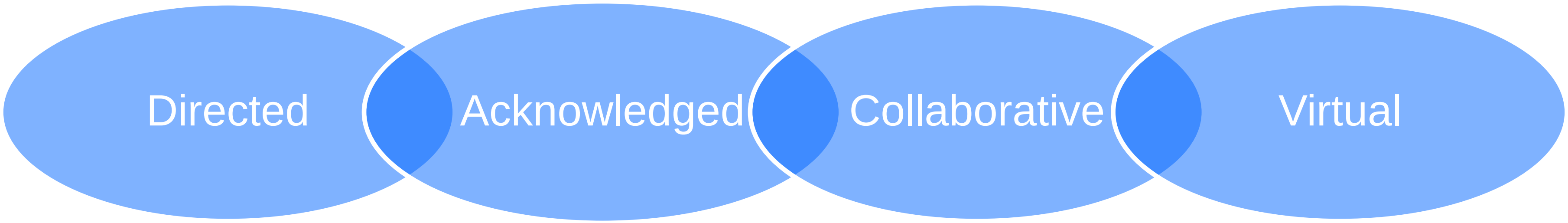
- Independent evolution of each constituent to respond to new technology and mission needs at its own pace and direction
- Evolution of the whole in response to changing demand

Emergent behavior

- "Whole is different than the sum of the parts"
- Indirect and cumulative effects of influences, actions, interactions

Maier, Mark W. "Architecting Principles for Systems of Systems," *Systems Engineering 1*, 4 (1998): 267–284.

Types of SoS*



Directed

- Integrated SoS, built and managed to fulfill specific purposes
- Centrally managed to maintain and evolve
- Constituents independent but subordinated to centrally managed purpose

Acknowledged

- Recognized objectives, designated manager and resources
- Constituents maintain independent ownership, objectives, funding, etc
- Changes based on collaboration between the SoS and the constituent

Collaborative

- Constituents interact more or less voluntarily to fulfill agreed central purposes

Virtual

- Lack central management authority and centrally agreed purpose
- Rely on relatively invisible mechanisms to maintain it

* DoD System Engineering Guide for System of Systems Engineering (Version 1.0, August 2008) & Maier

System of Systems Software Assurance Initiative

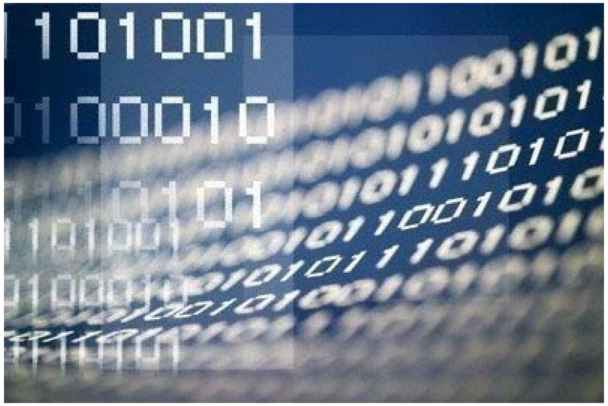
SoSSA Assurance Focus

System Assurance

- The justified confidence that a system functions as intended and is free of exploitable vulnerabilities, either intentionally or unintentionally designed or inserted as part of the system at any time during the life cycle*

Software Assurance

- Software's contribution to system and SoS assurance
  - Software assurance in the context of a system's mission and use



*** Engineering for System Assurance, NDIA System Assurance Committee, 2008, www.acq.osd.mil/sse/pg/guidance.html**

Initiative Scope and Goal

Scope

- Large-scale multi-user adaptive information management and C2 systems of systems (SoSs)

Goal: Methods and practices to provide

- Justified confidence that systems of systems will function as intended in their actual environment of use despite
  - The inevitable presence of various undiscovered defects and vulnerabilities
  - Unanticipated usage, environmental conditions, reconfiguration, or evolution
- Speedier delivery of fielded SoS capability

Integration & Interoperability

One Aspect: Integration and Interoperability

Currently, primarily interoperability issues surfaced at integration of the SoS for test and evaluation prior to fielding

- far too late in the systems engineering lifecycle to effectively and efficiently deal with the issues

Additional challenges with SoS

- underlying constituent systems in an SoS are constantly and independently evolving
  - producing a constant state of evolutionary and continual deployment

Need to surface (and mitigate) interoperability and integration issues earlier in the SoS lifecycle

Premise

Leverage insight from prior and existing DoD SoS

- DoD and industry sources

Re

- interoperability “failures” (and how to surface interoperability and integration issues earlier in the SoS lifecycle)
- what practices have facilitated better and quicker integration
- were there software approaches that could have helped mitigate the issues
- were there associated DoD policy, acquisition, and procedure challenges/barriers/incentives

Assumed anonymity/“genericized” unless explicit permission given

Overall Findings

Reluctance to discuss SoS interoperability “failures”/challenges, even with anonymity

Lack of “higher level” sharing of knowledge

- Software engineering issues, risks and lessons learned
- Organizational, management and governance
- Analysis, capture and dissemination
  - Experience (over years)
  - What has worked and what has not (post mortem)
- Time, cost and “not in the mainstream”

Magnification by SoS of existing, known software system problems plus new and emergent problems

Some Specific Comments from Interviews

Interoperability claimed but …

Find problems, do workarounds but then forget about problems – to be discovered again

No good processes that look at interoperability issues (id, avoid or mitigate them, disseminate solution (collection agency or repository))

Interoperability "personality" driven

- Individual takes it on to identify, document and work with programs to get it resolved

Different standards, interfaces, etc.

- Surface interoperability issues much earlier and develop mitigations or solutions (especially cross service)
  - Find the right people, at the right time, at the right level
- Even within service, may have different types of equipment that can't talk to one another
  - Trying to avoid dependence on one company (fair share)

Specific Comments: Leveraging the Learning Curve

Positive experience – in sustainment, doing things early, being proactive

After action reports, other lessons learned, “knowledge base”

- Sometimes the knowledge base is a person (personality and social networks)
  - “Human interoperability”
- Attempting to institutionalize it

Earlier in the life cycle – going against grain

- Still dealing with hardware, beginnings of software engineering, do some preliminary software interoperability
  - Not in contract, far down in WBS
- Knowledgeable people “on board” earlier – avoid mistakes or consider what has happened in similar situations

Artifacts

Currency, existence, completeness, and accessibility

- Architecture
- Design
- Rationale
- Assumptions
  - Implicit assumptions
  - Not machine-checkable
- Data and information
  - Semantic/lexicons
- Access to and incompatibility of information
  - Different tools
- Level of detail
  - Critical information not captured in artifacts
  - What is critical, what becomes critical (based on changes)

Identified Issues for Architecture/Architects

Do not have adequate software architecture documentation in place

- Modification to what the system is interfacing to
  - Time and money to bring “as is” architecture documentation up to date and still do the “to be” architecture documentation

Architect needs to talk directly with customer(s) to understand expected use

- Uncover interoperability issues

Similarly architect requires timely access to internal corporate subject matter experts

- Share expertise

Identified Testing Issues

Mission threads do not reflect current operational environment reality

Poor systems level testing done

Changes to various systems

- How do those changes affect the threads and tests

Core systems - one simple change of interface standard by a core system, caused many problems in other systems

Challenge: processes, artifacts, and collaborations in systems of systems are dynamic and ongoing, not static.

- Implies continual integration and test are necessary
  - Interim and incremental demonstration of interoperability, SoS functionality, and SoS capability

Evaluation and leveraging of evidence become increasing important

Identified Practice Issues

Integration, interoperability – mostly considered late in life cycle

- Earlier integration
  - Allow systems to come to test floor/op. environment prior to formal integration
  - Interoperability risk reduction exercises
    - C4ISR On-The-Move (integrated technology demonstration)
    - Tactical Network Topology (field experiment exercise environment)

Specific guidance (usually lower level)

- Net-Centric Enterprise Solutions for Interoperability [NESI]
  - Cross service effort (Army, Navy, DISA); http://nesipublic.spawar.navy.mil
  - "Body of architectural and engineering knowledge that guides
    - Design, implementation, maintenance evolution and use of IT portion of net-centric solutions for defense applications"
  - E.g. information interoperability: "To be able to share information, applications must be able to share data and to agree on its meaning" (access to data, semantic match)

DoD Policy, Acquisition, and Procedure Challenges/Barriers/Incentives

Most SoS are not Programs of Record

- Usually no specific SoS funding, authority, management or engineering
- At best, influence the new, or changes, upgrades

Individual systems do not consider larger context (interfaces, interdependencies, etc.)

Constant SoS evolution, continual deployment

- Coordination, collaboration amid change and turnover
- (Re)certification

Incentives and rewards focus on system, not SoS

- What is best or better for SoS, may not be optimal or desired for an individual system
- Challenges to meet system milestones/deliverables
- (Early)Dissemination of (potential) changes/problems to others detrimental to program/contractor

Request to Audience (from a SoS Point of View)

Pointers to and access to DoD and industry sources to leverage insight re

- Interoperability "failures" (and how to surface interoperability and integration issues earlier in the SoS lifecycle)
- What practices have facilitated better and quicker integration
- Were there software approaches that could have helped mitigate the issues
- Were there associated DoD policy, acquisition, and procedure challenges/barriers/incentives

Additionally seeking insight and information

- How conclusions about (software) system interoperability could be developed faster & more accurately by taking advantage of evidence gathered throughout the lifecycle
- Determine what evidence could be provided at different stages and how it could be used to develop justified predictions that a fielded system will not experience certain types of interoperability problems

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Improving Systems Engineering Curriculum Using a Competency-Based Assessment Approach

Alice Squires,
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School of Systems and Enterprises

Stevens Institute of Technology

Why Competencies?

- To meet government/industry needs … today.
- Government and Industry groups have defined knowledge, skills and abilities (competencies) that are important to their success.
  - behaviors, attitudes, attributes = also competencies
  - performance/output minimum = competences
- Curriculum can be designed to address these competencies.
  - learning objectives
  - course content
  - activities

What is a Competency-Based Approach?

- An approach to teaching and learning that is based on the successful student achieving a specific level of proficiency in a specific set of competencies.
- Compare:
  - current level – ‘as is’
  - desired level – ‘to be’
- Identify gaps – focus areas
- Put a plan in place to bridge the gap

An Example of 'Individual' SE Competency Models -- FAA

- FAA SE Manual, October 11, 2006: http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/operations/sysengsaf/seman/
  - Armstrong, J. R., & Henry, D. (2009). Competencies required for successful acquisition of the next generation air transportation system. In *IEEE syscon 2009, 3rd annual IEEE international systems conference, vancouver, canada, march 23-29, 2009.*
  - Armstrong, J., Henry, D., & Pyster, A. (2009, September 8). *Systems engineering, systems integration, and software engineering competencies required for successful acquisition of the next generation air transportation system. School of Systems and Enterprises, Stevens Institute of Technology, Castle Point on Hudson, Hoboken, NJ.*
  - Turner, R., Verma, D., & Weitekamp, W. (2009, August 31). *The next generation air transportation system (nextgen). School of Systems and Enterprises, Stevens Institute of Technology, Castle Point on Hudson, Hoboken, NJ.*

Other examples: MITRE, SAIC, BAE Systems, Nokia, Boeing, LM, etc….

Examples of 'Jointly' Developed SE Competency Models

- DAU Systems Planning, Research, Development and Engineering (SPRDE)–SE/PSE Model: https://acc.dau.mil/CommunityBrowser.aspx?id=315691
  - Analytical (13), Technical Management (12), Professional (4)
- INCOSE UK: Systems Engineering Competencies Framework and Guide to Competency Evaluation
  - final due out Oct 2009
  - Holistic LifeCycle, Systems Thinking, Systems Engineering Mgmt
- NASA/Industry: See http://www.nasa.gov/pdf/303747main_Systems_Engineering_Competencies.pdf
  - Model shown and used in this presentation

NASA/Industry SE Competency Model

- International Academy of Astronautics (IAA): Space industry SE competency model:
  - 10 Competency Areas
  - 37 Capabilities within these ten areas
  - 4 Proficiency Levels
- Successfully Leveraged to Develop Stevens' SSE Domain Centric Space Systems Engineering Masters Program
- Used to Assess Legacy Core Courses for Stevens' SSE SE Discipline Centric Masters Program

Ten Competency Areas (# of capabilities)

1. Concepts and Architecture (4)
2. System Design (4)
3. Production, Product Transition and Operations (6)
4. Technical Management (8)
5. Project Management and Control (4)
6. Organizational Environments (3)
7. Human Capital Management (2)
8. Security, Safety and Mission Assurance (2)
9. Professional and Leadership Development (3)
10. Knowledge Management (1)

Four Proficiency Levels*

- Level I – **Participate (Know)**: Performs fundamental and routine SE activities while supporting a Level II-IV systems engineer as a member of a project team
- Level II – **Apply (Perform)**: Performs SE activities for a subsystem or simple project (e.g. no more than two simple internal/external interfaces, simpler contracting processes, smaller team/budget, shorter duration)
- Level III – **Manage (Lead)**: Performs as a systems engineer for a complex project (e.g. several distinct subsystems or other defined services, capabilities, or products and their associated interfaces)
- Level IV – **Guide (Strategize)**: Oversees SE activities for a program with several systems and/or establishes SE policies at top organizational level.

*from NASA's Academy of Program/Project and Engineering Leadership (APPEL)

Space Systems Engineering Example

	Fundamentals of Systems Engineering	System Architecture and Design	Designing Space Missions and Systems	Mission and System Design Verification & Validation	Systems Integration	Project Management of Complex Systems	Human Spaceflight	Space Launch and Transportation Systems	Cost Effective Space Mission Operations	Crew Exploration and Vehicle Design	Modeling and Simulation	Design for Reliability, Maintainability and Supportability	Decision and Risk Analysis
	Core						Specialty						
1.0													
1.1	X	X					X	X	X	X			
1.2	X	X	X		x*		X	X	X	X			
1.3	X	X	X		x*		X	X	X	X	X	X	X
1.4	X	X			x*					X		X	
2.0													
2.1	X	X				X	X	X	X	X	X	X	X
2.2	X	X		X	X		X	X	X	X		X	
2.3		X											
2.4		X	X	X	x*		X	X	X	X		X	
3.0													
3.1	X												
3.2		X		X	X								
3.3	X		X	X	X								
3.4	X			X	X								
3.5													
3.6			X					X	X				

x* - for enabling systems

The Team: Years of Experience

	Government/ Industry	Research/ Academia	SE Related	*TOTAL*
1	42	1	**43**	***43***
2	35	5	**35**	***40***
3	27	3	**23**	***30***
4	29	3	**20**	***32***
5	27	6	**30**	***33***
6	26	12	**18**	***38***
7	21	10	**10**	***31***
8	6	6	**5**	***12***
9	30	9	**39**	***39***
10	26	7	**23**	***33***
11	23	4	**13**	***27***
12	27	4	**15**	***31***
13	9	12	**20**	***21***
	328	82	**294**	***410***

Process

- Select the Competency Model to Use
- Validate the ‘Critical’ Competencies
- Identify the ‘As is’ State of the Curriculum
- Identify the ‘To Be’ State of the Curriculum
- Summarize/Evaluate the Gap Areas
- Put a Plan of Action in Place to Assess those Gaps
- Revisit!

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Validate the Competencies

Systems Engineering Capabilities	IAA Global 'Apply'	Stevens 'Apply'	
3.0 Production, Product Transition and Operations			
3.1 Implement the Product	Optional		5
3.2 Integrate System	**Critical**	**Critical**	**10**
3.3 Verify the System	**Critical**	**Critical**	**9**
3.4 Validate the System	**Necessary**	**Critical**	**9**
3.5 Transition the System	Optional		4
3.6 Conduct Operations	Necessary		2

Determine Current State: 'As is'

Stevens Institute of Technology: Critical Systems Engineer Capabilities	Fundamentals of Systems and Software Engineering	System Architecture and Design	Systems Integration	Project Management of Complex Systems
3.0 Production, Product Transition and Operations				
3.2 Integrate System		Low	Medium	
3.3 Verify the System	Medium		Medium	
3.4 Validate the System	Medium		Medium	

School of Systems & Enterprises

STEVENS Institute of Technology

Determine Desired State: ‘To Be’

Stevens Institute of Technology: Critical Systems Engineer Capabilities	Fundamentals of Systems and Software Engineering	System Architecture and Design	Systems Integration	Project Management of Complex Systems
3.0 Production, Product Transition and Operations				
3.2 Integrate System		Low	**High**	
3.3 Verify the System	Medium		**High**	
3.4 Validate the System	Medium		**High**	

Evaluate Gaps

Stevens Institute of Technology: Critical Systems Engineer Capabilities **1 circle = Low** **3 circles = Medium** **5 circles = High** **● = current 'as/is'** **❍ = 'to/be'**	Fundamentals of Systems and Software Engineering	System Architecture and Design	Systems Integration	Project Management of Complex Systems
3.0 Production, Product Transition and Operations				
3.2 Integrate System		●	●●●❍❍	
3.3 Verify the System	●●●		●●●❍❍	
3.4 Validate the System	●●●		●●●❍❍	

Develop an Action Plan

Systems Integration		
SE Capabilities	**Gaps**	**Examples of Potential Actions To Address Gaps**
3.0 Production, Product Transition and Operations		
3.2 Integrate System^{P}	●●●❍❍	Increased emphasis will be placed on integration strategies to address interface risks early in a program.
3.3 Verify the System^{P}	●●●❍❍	May introduce Design of Experiments (DOE) in this context.
3.4 Validate the System^{P}	●●●❍❍	Increased emphasis on tie to risk of non-acceptance of system by the customer.

Related Journal Papers To Be Published

- Squires, A., Larson, W., and Sauser, B. (2010). "Mapping Space-Based Systems Engineering Curriculum to Government-Industry Vetted Competencies for Improved Organizational Performance", *Systems Engineering, 13(2 or 3), TBD.*

- Squires, A., and Larson, W. (2009). "Improving Systems Engineering Curriculum Using a Competency-Based Assessment Approach", Special Issue on Systems Engineering Education of the *International Journal of Intelligent Defence Support Systems (IJIDSS), TBD(TBD), TBD.*

Thank You!

Questions?

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Generating Visual and Interactive Output from System Engineering Tools

John Schatz / SPEC Innovations

29 October 2009

Overview

- Methodology
- KBAD Schema
- Information Capture Process
- Risk Matrix Visualization
- TPM Capture and Visualization
- Expandable-Collapsible Tree Visualization
- Geo-Spatial Visualization

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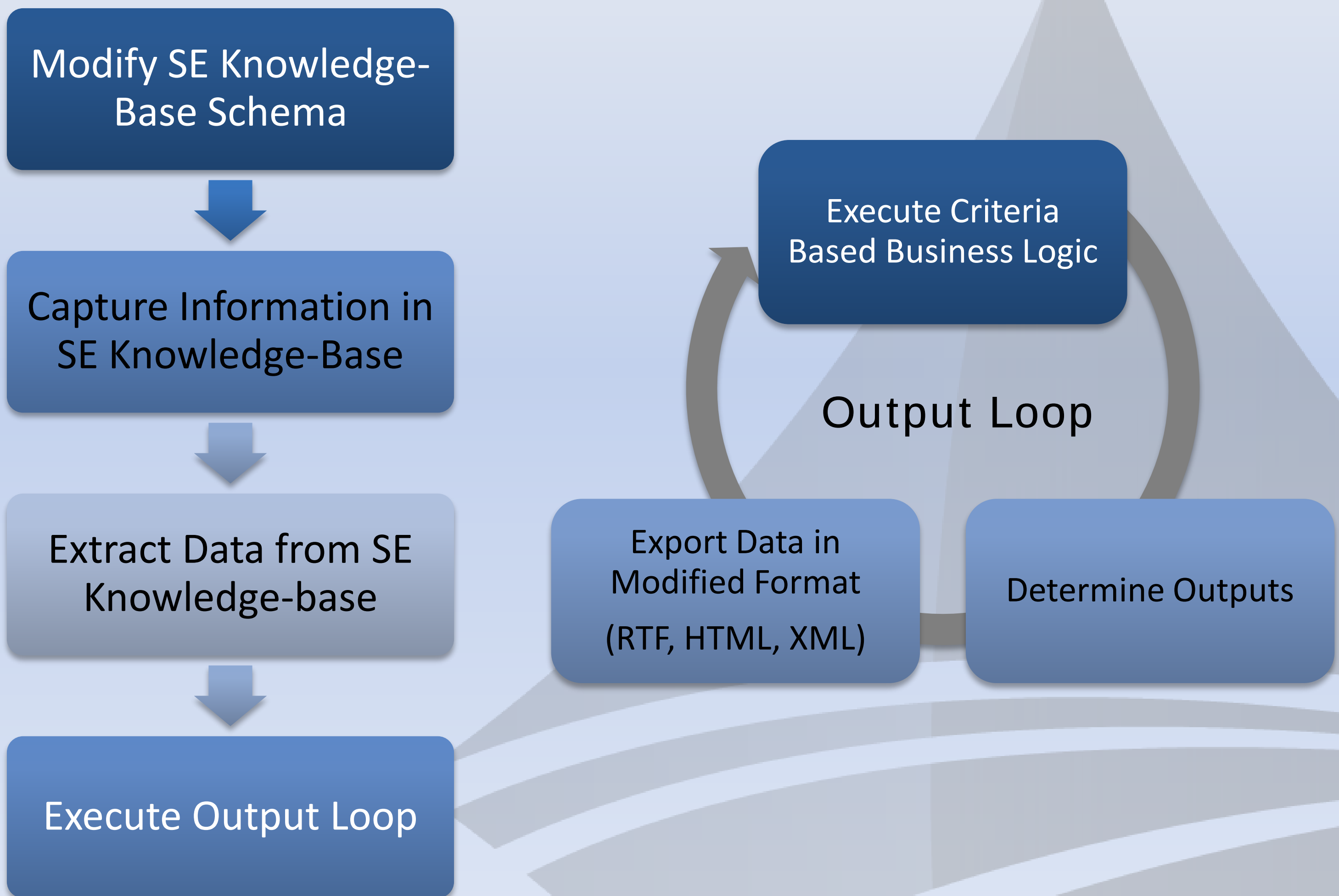
Methodology



KBAD Schema

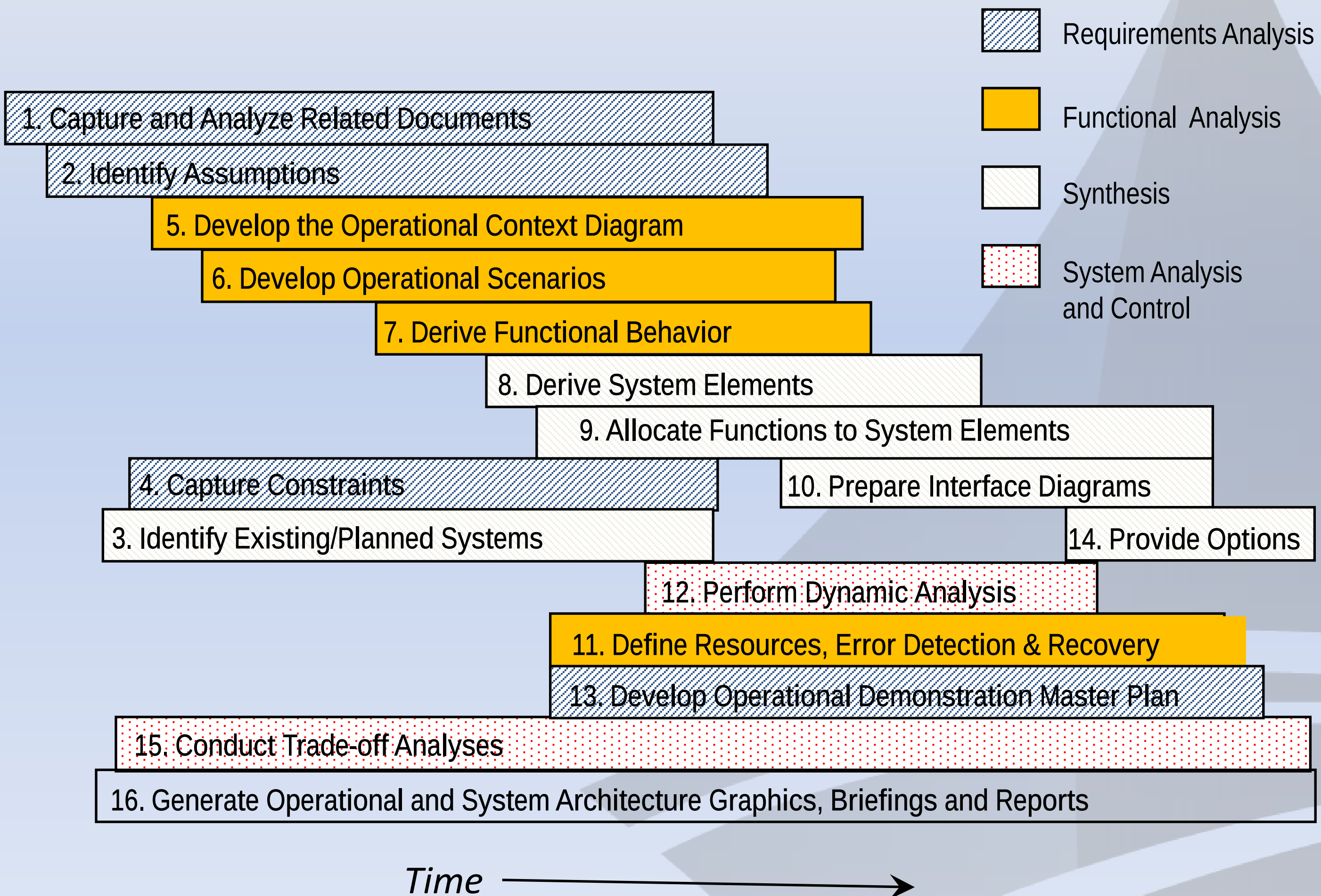
KBAD* Element	CORE Elements	Rationale
Action	Function/Operational Activity	Provide overall class for actions
Artifact	Document	Recognized not just documents
Asset	Component/Operational Element	Provide overall class for assets
Characteristic	type of Requirement	Way to capture metrics and other characteristics of an element
Cost	attribute of Component	Broadens capture of costs
Input/Output	Item/Operational Information	Clearer name
Issue	Issue	Same
Link	Link/Needline	Provide overall class for transmission
Location	none	Captures geolocation information
Risk	Risk	Same
Statement	type of Requirement	Clearer name
Time	attribute of Function	Broadens capture of times

The KBAD Schema supports the capture of data items and relationships utilized in the examples.

*Knowledge-Based Analysis and Design

SPEC INNOVATIONS

Capture Information in SE Knowledge-Base



The KBAD middle-out approach has been proven on a variety of projects.

Risk Matrix Example

Risk Characterization Summary

	C1	C2	C3	C4	C5
L5					
L4				R.10, R.2	
L3		R-1	R-2, R-3, R-4, R-5, R-6, R-7, R.1, R-8	R-9	
L2					
L1			R-10		

Figure 1 Risk Characterization Summary Matrix

Consequence Impact: C1 = Negligible, C2 = Minor, C3 = Moderate, C4 = Serious, C5 = Critical
Likelihood: L1 = (0-10), L2 = (10-40), L3 = (40-60), L4 = (60-90), L5 = (90-100)
Risk Characterization: Green = Low, Yellow = Moderate, Red = High

Risk Matrix Example - Logic

1. Extract Risks of interest.
2. Create lists of risks for each Risk Matrix cell by examining the risks' consequences and likelihoods.
3. Begin streaming RTF file up to first cell.
4. Set cell color. The cell colors are fixed.
5. Insert risks for given cell.
6. Etc.

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TPM Example

	Technical Performance Measures					
	Current	Projected	Threshold	Objective	Units	Imp.Dir.
Hardware Assets						
SBPG Ground Element						
TPM: Ground Element MTTR	60.0	31.0	30.0	15.0	minutes	Negative
SBPG On-Orbit Element						
TPM: On-Orbit Element Lifespan	13.0	15.2	10.0	15.0	years	Positive
TPM: On-Orbit Element Transmission Efficiency	0.63	0.65	0.65	0.75		Positive
TPM: On-Orbit Element Weight	6500.0	5800.0	6000.0	5000.0	kg	Negative
System Functions						
Execute Maneuver Commands						
TPM: Characteristic_001	10.0	13.2	11.0	13.0	seconds	Positive
Issue Maintenance Alert						
TPM: Characteristic_002	0.95	0.97	0.95	0.98		Positive
Collect Solar Energy						
TPM: Characteristic_003	0.65	0.66	0.6	0.65		Positive

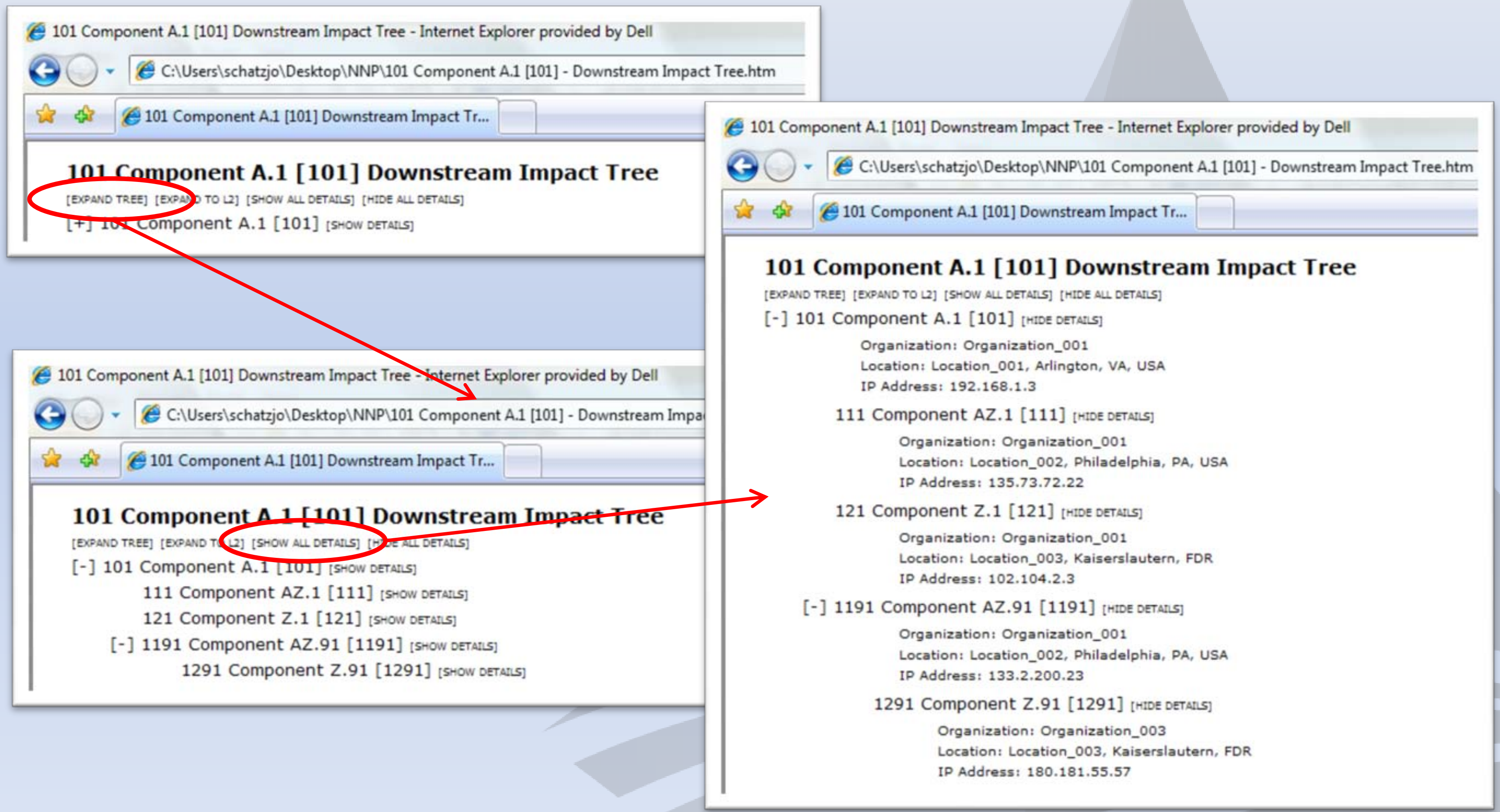
Figure 1 SBPG Context Performance Parameters Matrix

Value Characterization: Green = Exceeds Objective, Yellow = Between Threshold and Objective, Red = Does Not Meet Threshold

TPM Example - Logic

1. Extract TPMs for systems of interest.
2. Begin streaming RTF file up to first System row.
3. Insert System name.
4. Stream up to the system's first TPM.
5. Insert TPM name.
6. Compare current and projected values against threshold and object values taking improvement direction into account.
7. Determine cell color based on predetermined criteria.
8. Insert color coded cells with current and projected values.
9. Etc.

Expandable-Collapsible Tree Example



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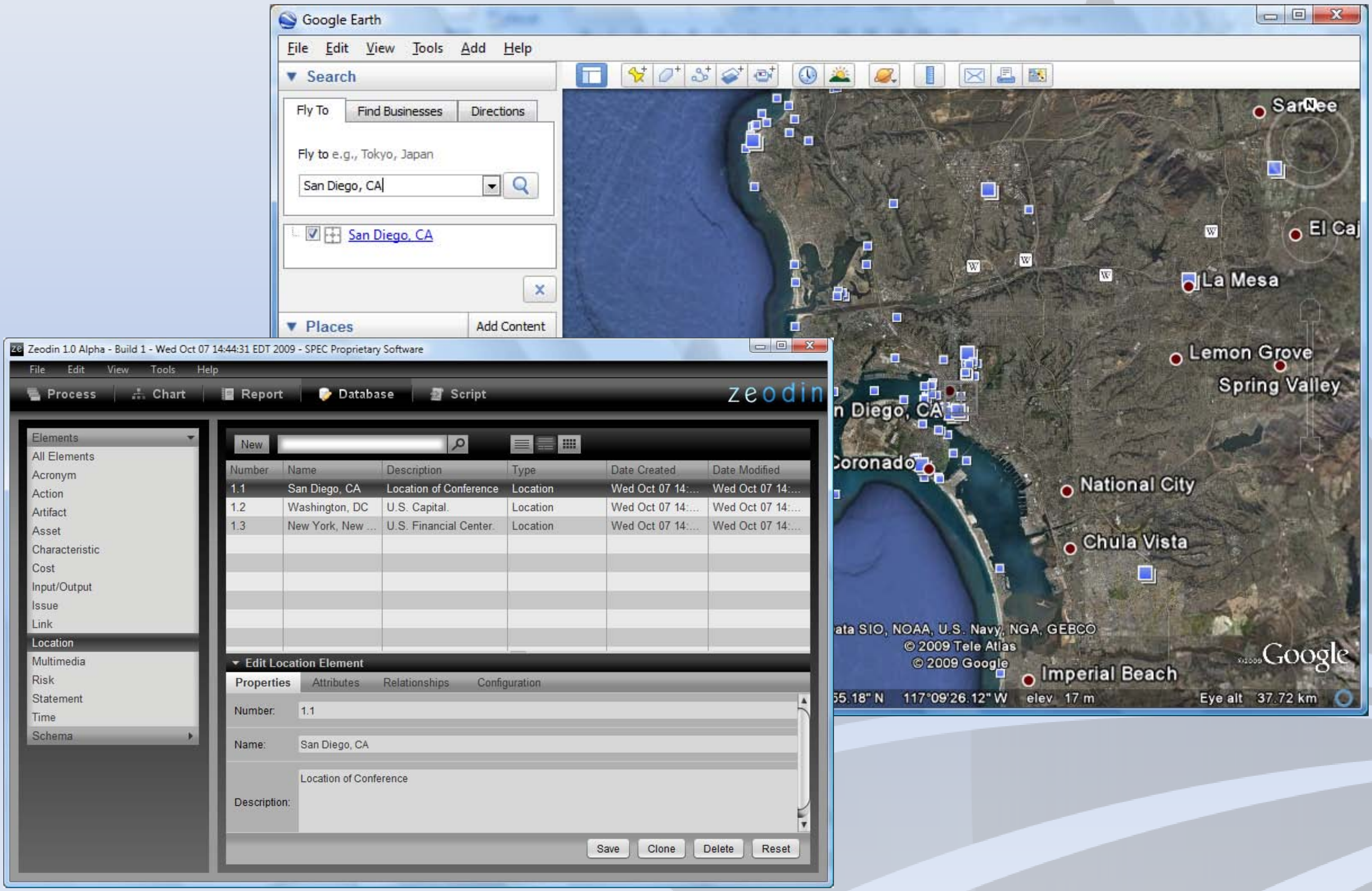
Expandable-Collapsible Tree Example - Logic

1. Write JavaScript and CSS files.
2. Extract nodes in an interconnected nodal network.
3. Generate index file of all nodes.
4. Iterate through nodes doing the following for each:
   1. Generate expandable tree branches and leaves. Prevent closed loops.
   2. Begin streaming HTML file with JavaScript and CSS files referenced.
   3. Store controls and tree data in JavaScript node array.
   4. Store starting positions in JavaScript position array.
   5. Encode nodes into HTML file as absolutely positioned items with embedded JavaScript commands to access Document Object Model (DOM) for hiding or showing nodes.

Geo-Spatial Example



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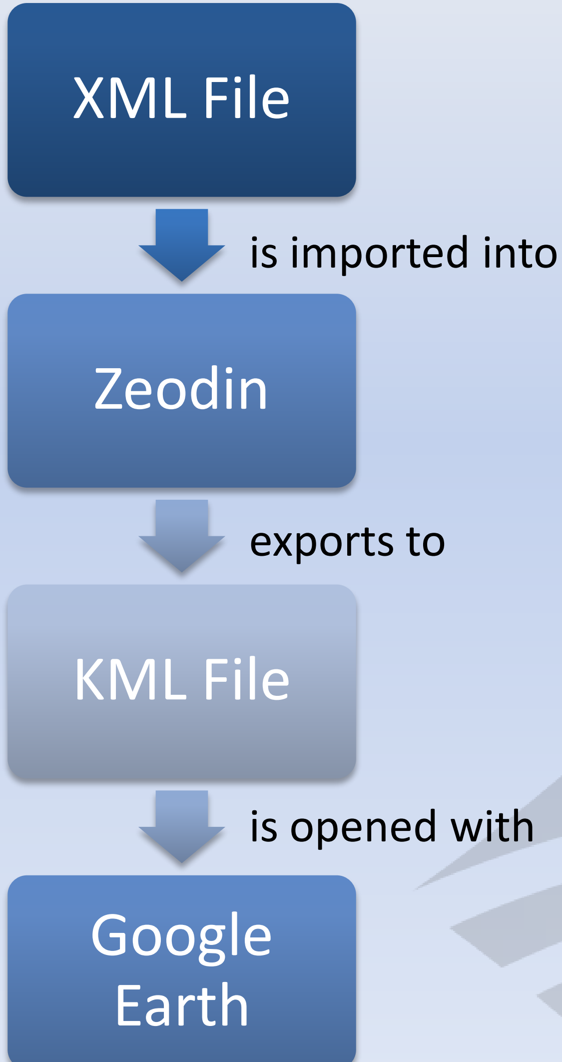
Geo-Spatial Example - Logic



1. Generate KML header information.
2. Extract assets from SE Knowledge-Base.
3. Iterate through assets streaming asset specific KML.

Summary

- Use of other products for visualization is necessary, since most SE tools provide poor graphics for a general audience
- Output from COTS Products can be modified to enhance visualization
- Most tools provide scripting that enable creative visualization

An Introduction to Influence Maps: Foundations, Construction, and Use

Jim Smith
NDIA Systems Engineering Conference
October 29, 2009

Overview

This presentation will provide an overview of Influence Maps (IMs), a graph-based technique—central to Influence Mapping Analysis (IMA)—for understanding system-of-systems interoperability issues

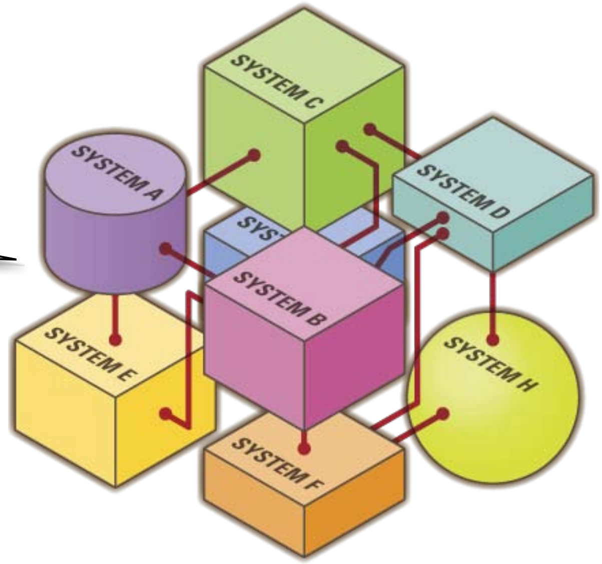
Topics include:

- Foundations for IMs
- Construction and use of IMs for governance- and acquisition-related interoperability risks

Multiple Perspectives on System of Systems -1

SoS are a collection of integrated and interoperable hardware and software entities providing capabilities that fulfill specific functional and operational needs

Technical View

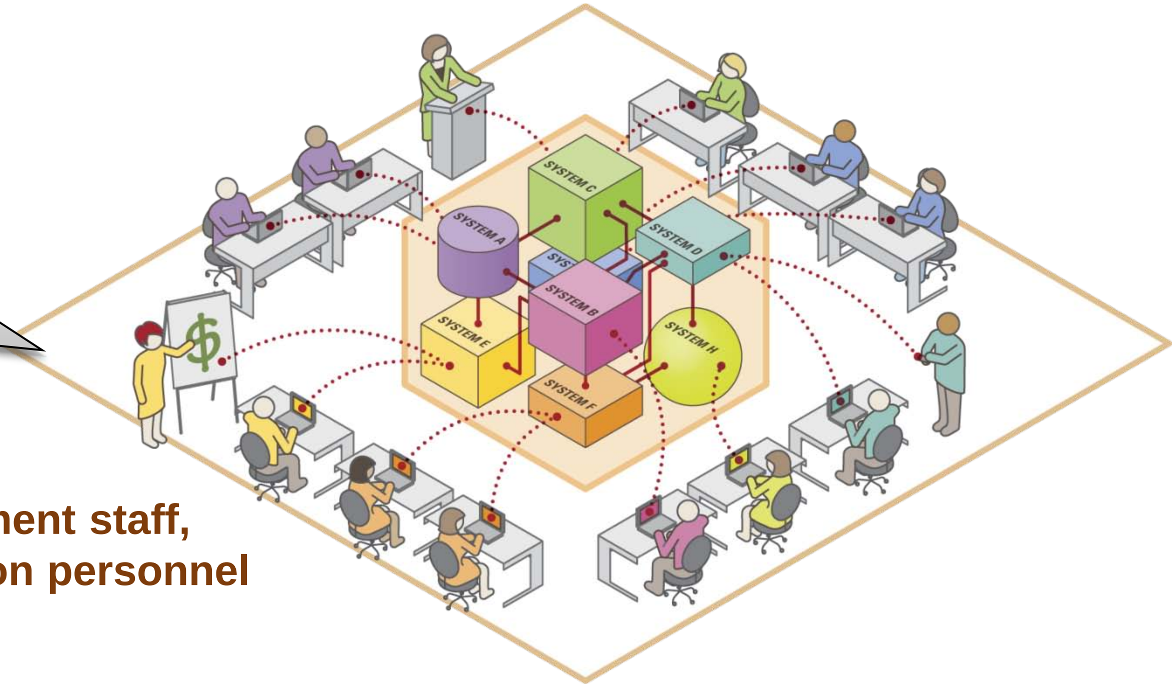


But…systems of systems are more than interoperating hardware and software systems

Multiple Perspectives on System of Systems -2

An SoS is a collection of people and organizational entities involved in acquiring and composing “systems of systems” that provide capabilities to fulfill specified functional and operational needs

Development/ Acquisition View



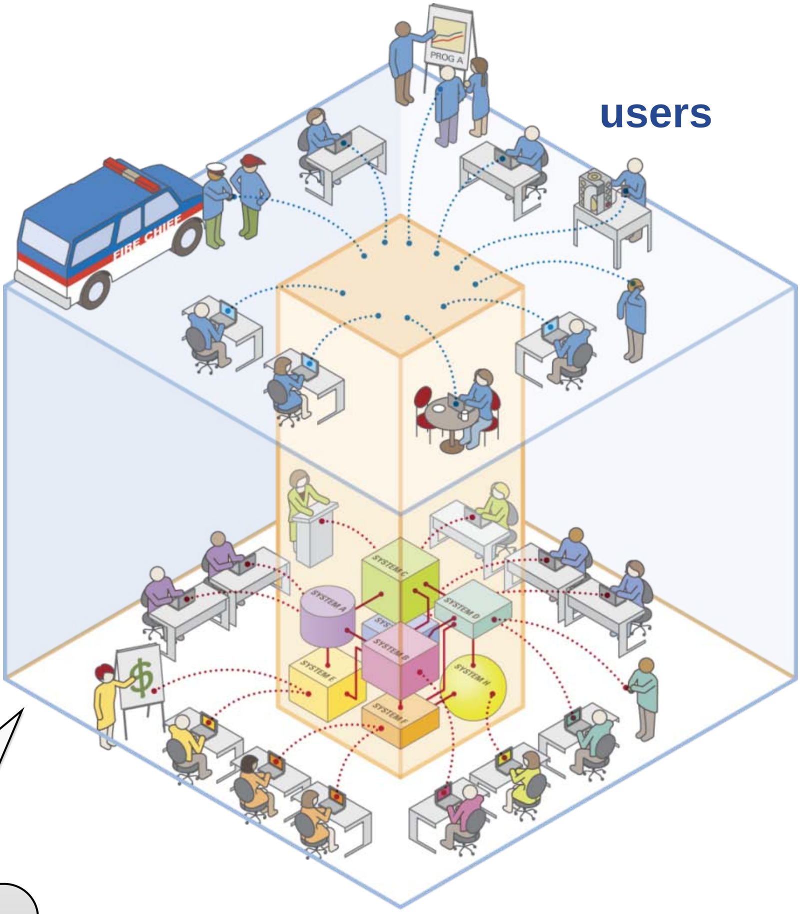
Development staff, acquisition personnel

People systems are as important as technical systems

Multiple Perspectives on System of Systems -3

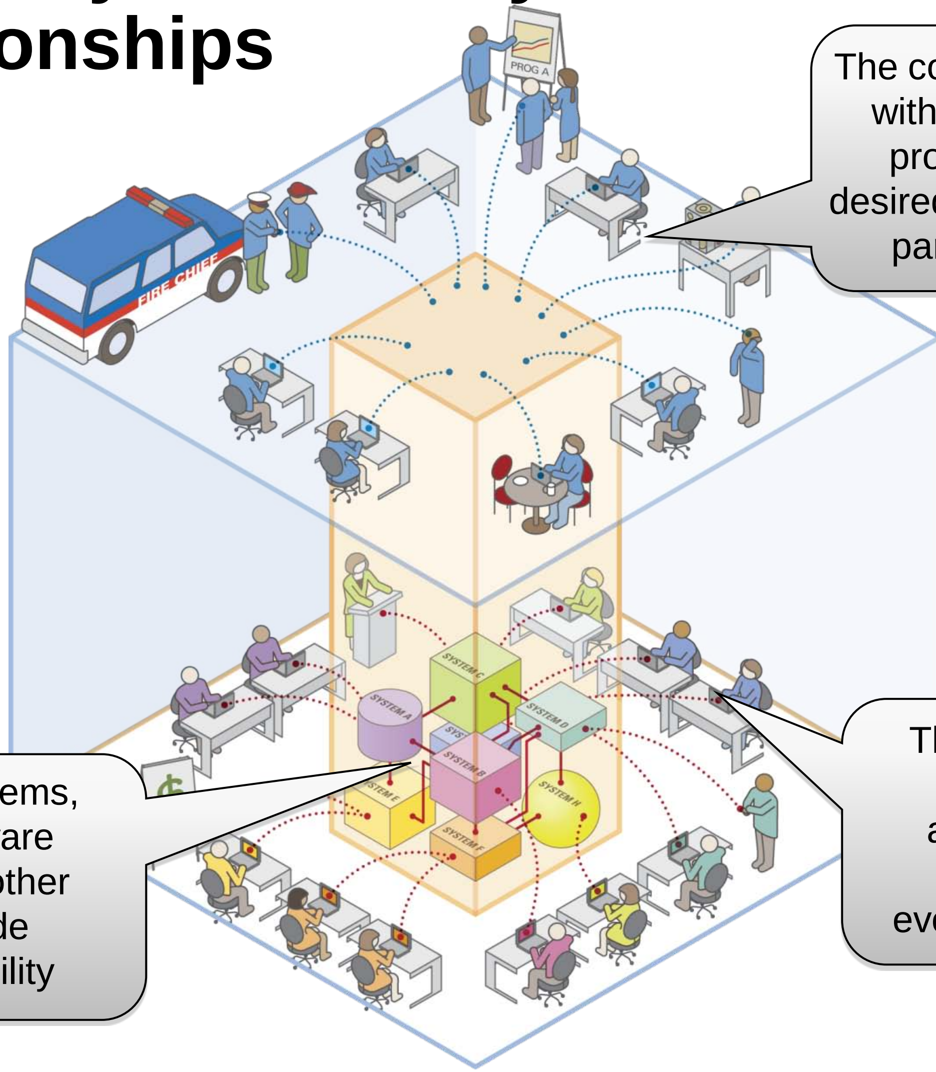
SoS provide capabilities that enable a collection of operational users to achieve the effects they need to meet their business/mission goals

- Evolves to enable dynamically changing operational effects within the operational user's context of use
- Is likely to use technical and organizational assets outside of the original design context



Operational Effects/ User View

Key Point: Systems of Systems Result from Interrelationships



The composition of capabilities with users and operational processes that achieves desired operational effects for a particular context of use

Aggregation of systems, hardware or software components, and other devices to provide operational capability

The people, organizations, and interrelationships associated with building, acquiring, fielding, and evolving systems of systems

Understanding Interrelationships and Influence

Various techniques exist to represent interrelationships in socio-technical systems, including:

- Network diagrams
- Functional Flow Block Diagrams
- Conceptual Graphs
- IDEF0/IDEF3
- PERT Charts

Challenges in applying to systems of systems

- Complexity of resulting representation
- Difficulties in representing/reasoning about “background” knowledge
- Problems in representing/reconciling conflicting/contradictory influences

Influence Maps (IMs)—and IM Analysis (IMA)—provides a simple way to identify, understand, and analyze influence interrelationships

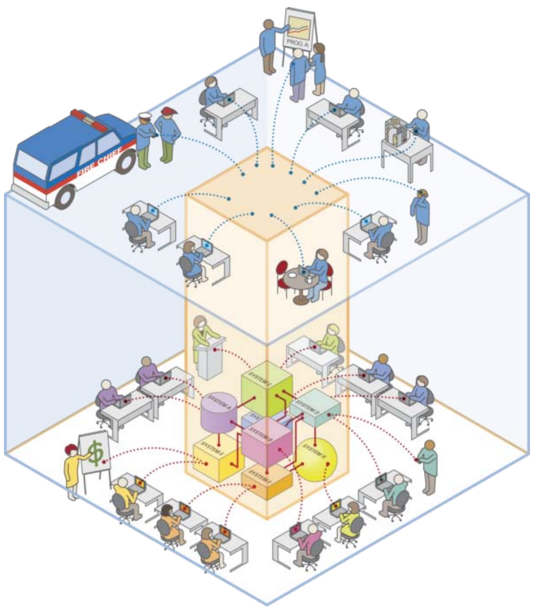
- Permits the discovery of influences that impact governance, acquisition, and engineering for systems of systems
- Supports the identification, characterization, and reconciliation of ambiguous and contradictory influences
- Input to formal analysis/reasoning framework and decision aids

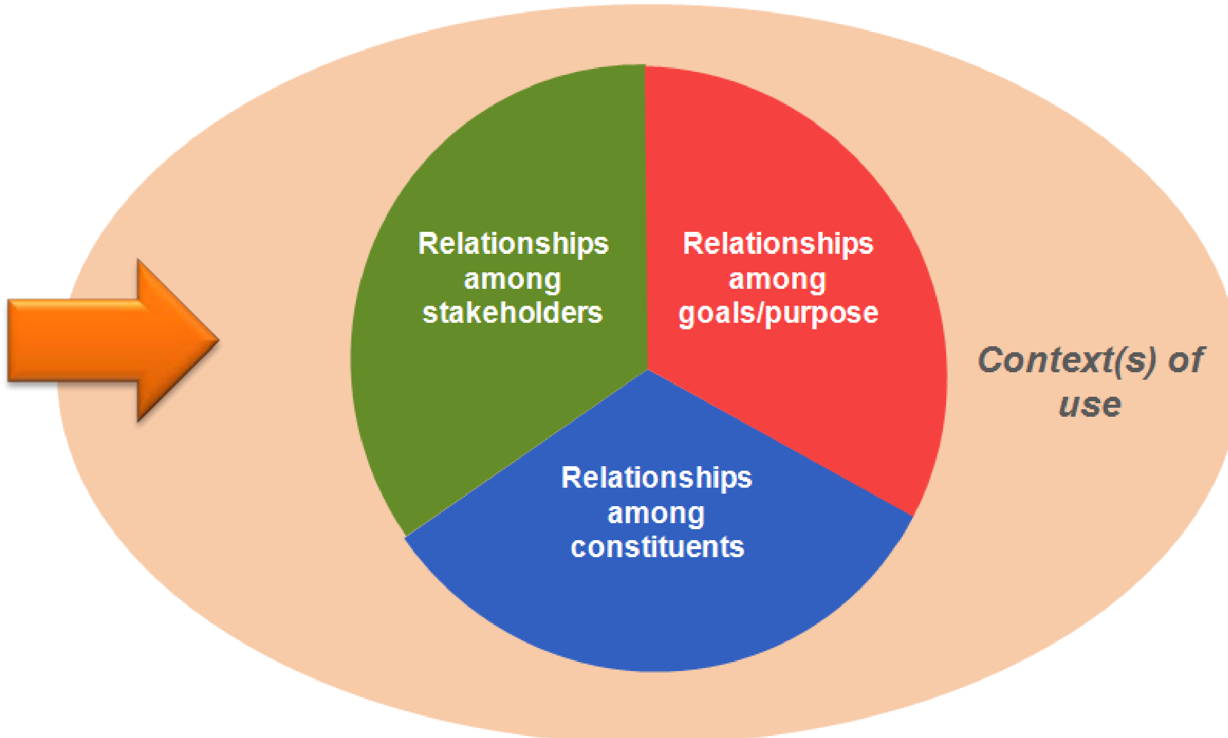
Key Concepts of IMs and IMA

Influence mapping analysis is built around several key concepts

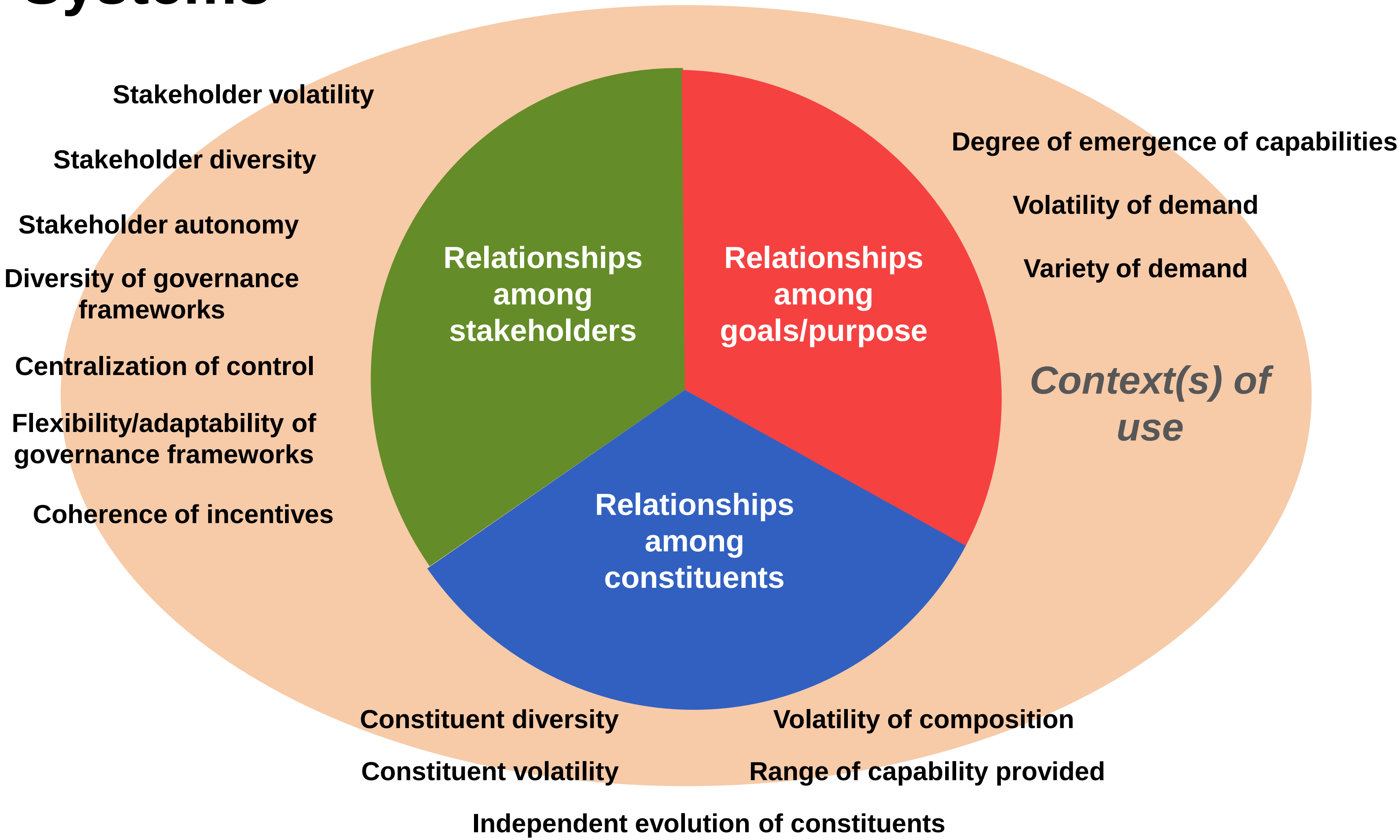
- Use of IMs to identify, characterize, and understand influence relationships
- Resolving divergent perceptions of the actual conditions: the so-called "ground truth"
- Analyzing patterns of influence relationships for indicators of SoS risks
- Use of a contextually-driven discovery process

Understanding the Relationships Implied by the SoS Perspectives





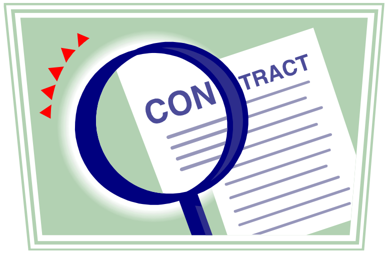
Relationship Characteristics of Systems of Systems



Forms of Interrelationships

The interrelationships in socio-technical systems—and the workings of their influence—vary widely:

- Contract language
- Statutory/regulatory requirements
  - Defense Appropriation Act
  - HIPAA
  - Federal Acquisition Regulations
- Technical requirements
- Reporting requirements
- “Giver/receiver” relationships
- Funding
- Individual trust



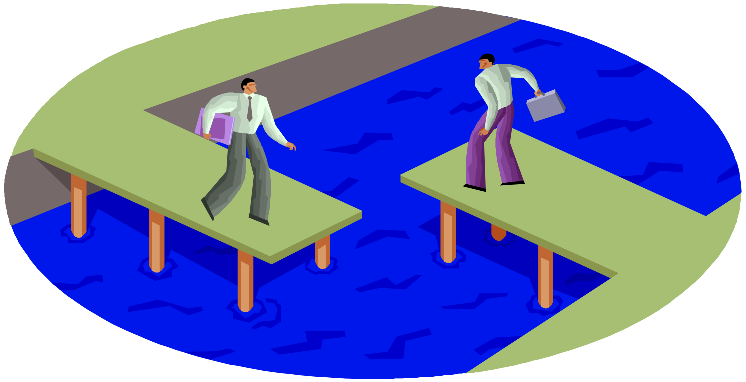
Managing Divergent Perceptions -1

SoS participants can have a different understanding of relevant influence relationships

- Important influence relationships are often implicit, or only tacitly acknowledged

These inconsistencies can—and frequently do—lead to unfortunate technical and programmatic decisions that result in:

- Cost growth
- Schedule delays
- Performance shortfalls



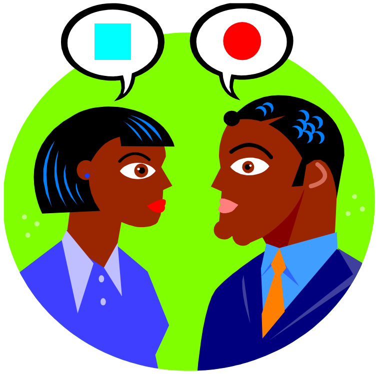
Managing Divergent Perceptions -2

Explicit versus tacit/implicit, “official truth” versus “ground truth”

- *Official truth* is reflected explicitly in various policy statements, organization charts, program plans, directives, memoranda, etc.
- Frequently at odds with real conditions (e.g., actual—versus ideal—programmatic relationships, “back channel” communications) that define the *ground truth*
- Much of this information exists as tacit or implicit knowledge

Before you can understand what is actually happening—and why—underlying assumptions and expectations must be made explicit

- What is the influence?
- Between what parties?
- For what purpose?
- How effected?
- With what assurance?
- As verified by?



Patterns of Influence Relationships

Patterns of influence relationships can provide indications of potential risks

Examples

- Cycles, or loops
(e.g., “A” has a schedule dependency on “B,” which has a schedule dependency on “C,” which has a schedule dependency on “A”)
  – Can lead to programmatic “race conditions” because of the delay between the time that an event occurs (e.g., delivery date delayed by rework to correct problems discovered during testing) and when it becomes known to other participants
- Hidden—or indirect—dependencies
(e.g., “A” has a schedule dependency on “B,” which has a backwards compatibility relationship with “C,” resulting in “A” having an indirect dependency on “C”)
  – Can result in major impacts from seemingly unrelated decisions

Construction and Use of IMs for IMA

IM Analysis (IMA) comprises four steps:

1. Construct “strawman” IMs
2. Refine/extend IMs during discovery process
   – Create multiple node- and agreement-centric IMs representing relevant stakeholders’ perspectives
3. Prepare composite IMs, and analyze for inconsistencies, gaps, clashes, patterns
4. Develop risk mitigation strategies

Three types of IMs:

Context-centric: Provides a high-level overview of the entire system-of-systems context, including all relevant participants

Node-centric: Represents influence relationships, as seen from the perspective of a single participant

Agreement-centric: Provides detailed representation of an individual influence relationship, including semantics

Strawman IMs

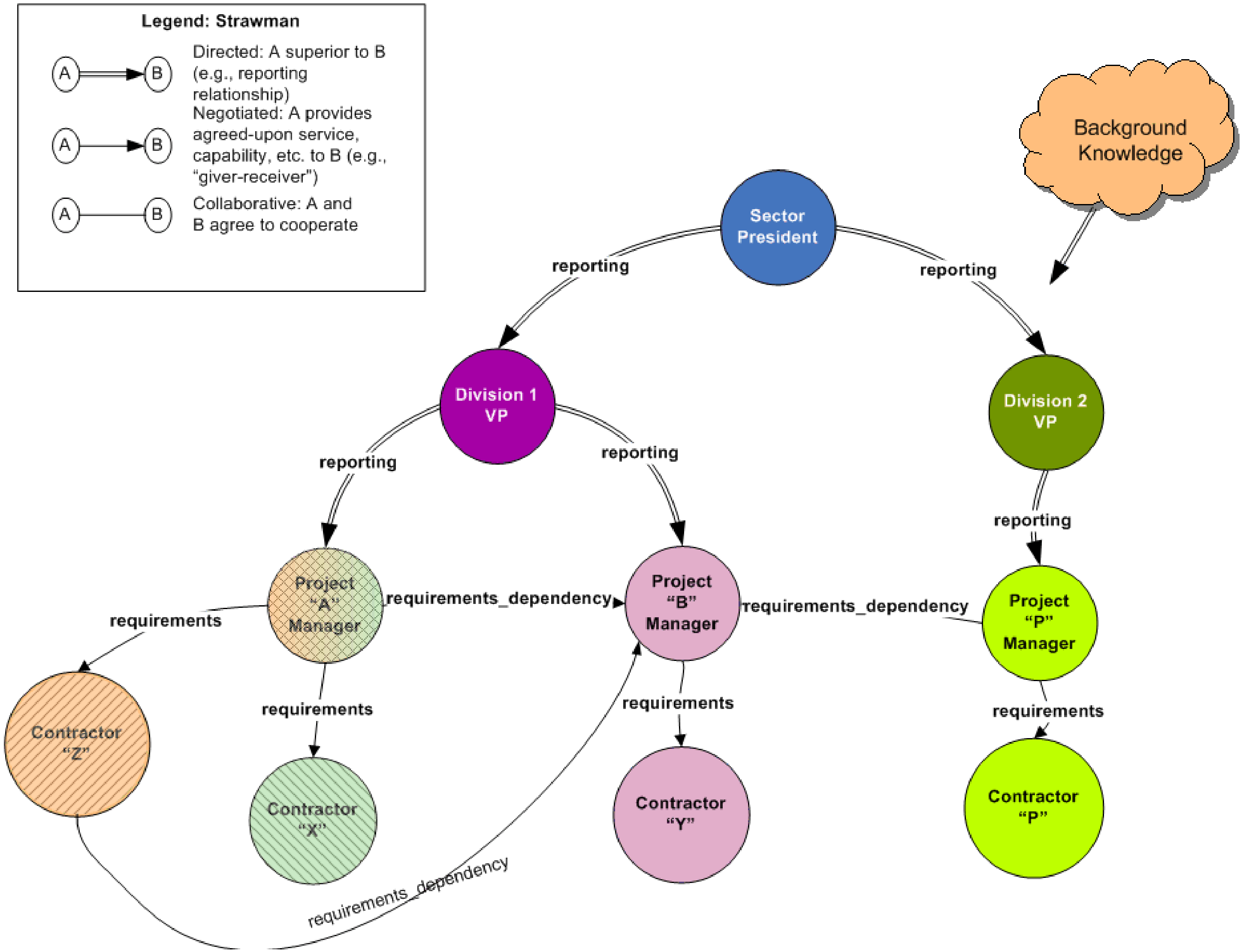
Context-centric IM provides a high-level, overview of entire system-of-systems context

- Includes major participants and influence relationships that comprise the key technical and programmatic drivers

Strawman context-centric IM based on documentation provided by subject organization and IMA team expert judgment

- Serves as basis for discovery process
- Could use outputs from a Critical Context Analysis (CCA) as an input

Example: Strawman Context-Centric IM



Discovery

Three goals of discovery process:

1. Identify the most critical, pacing requirements that drive the SoS context
2. To identify relevant internal and external stakeholders and characterize their key concerns, motivations, needs, etc.
3. To develop context-, node-, and agreement-centric IMs that reflect the "ground truth" for the relevant influence relationships

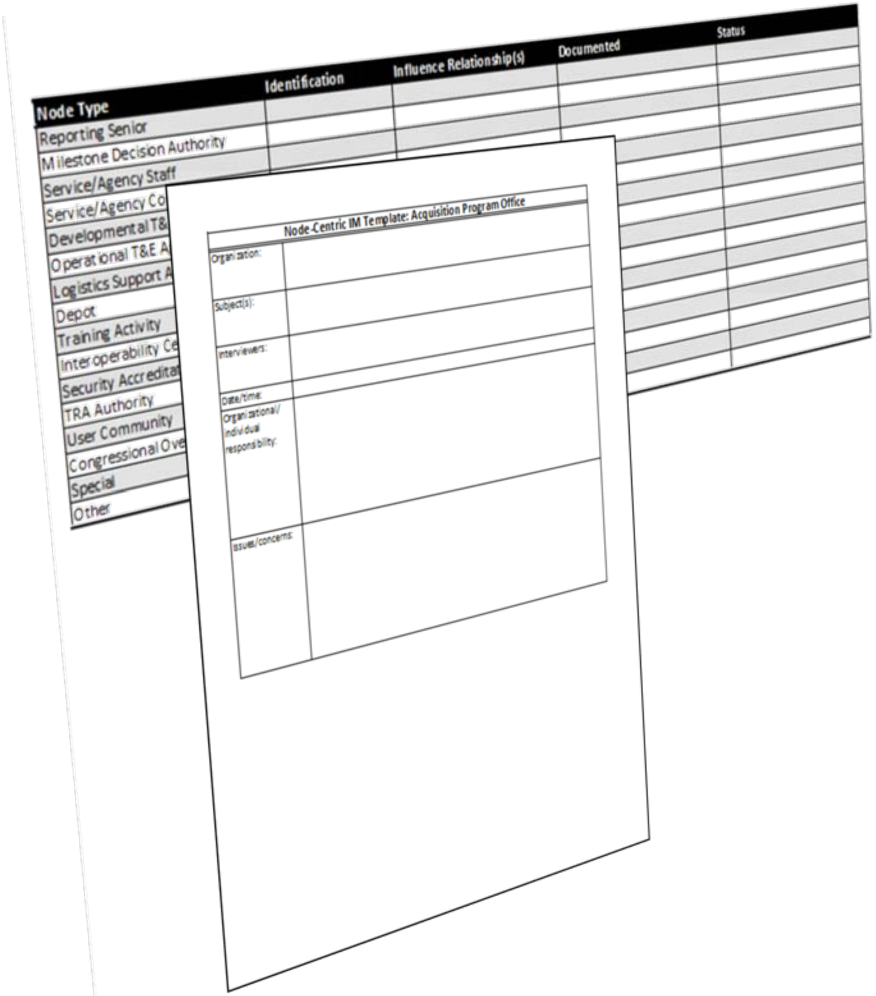
Contextually-Driven Discovery

Uses scenarios that relate to a participant's context within an SoS (e.g., acquisition program office, operational tester), augmented with influence relationship templates, to structure participant interviews

- Example: Your program's budget has been cut as a result of a Congressional Committee "mark." How do you evaluate the impact of this action on your ability to satisfy you program cost, schedule, and performance goals? Who do you interact with in making this determination? What information do you need to evaluate? etc.

Captures and characterizes assumptions about other stakeholder roles and responsibilities

Templates Support Contextually-Driven Discovery



Aids elicitation of influence relationships

- Different templates for different SoS perspectives (e.g., acquisition program office) and contexts (e.g., budget cut, schedule slip)
- Lists typical classes of nodes with which subject would reasonably be expected to have influence relationships (e.g., milestone decision authority, user community)
- Used to record types of relationships, how they are documented, their status, etc.

Serves as input to generation of “discovery” IMs

- Each row defines one or more influence relationships

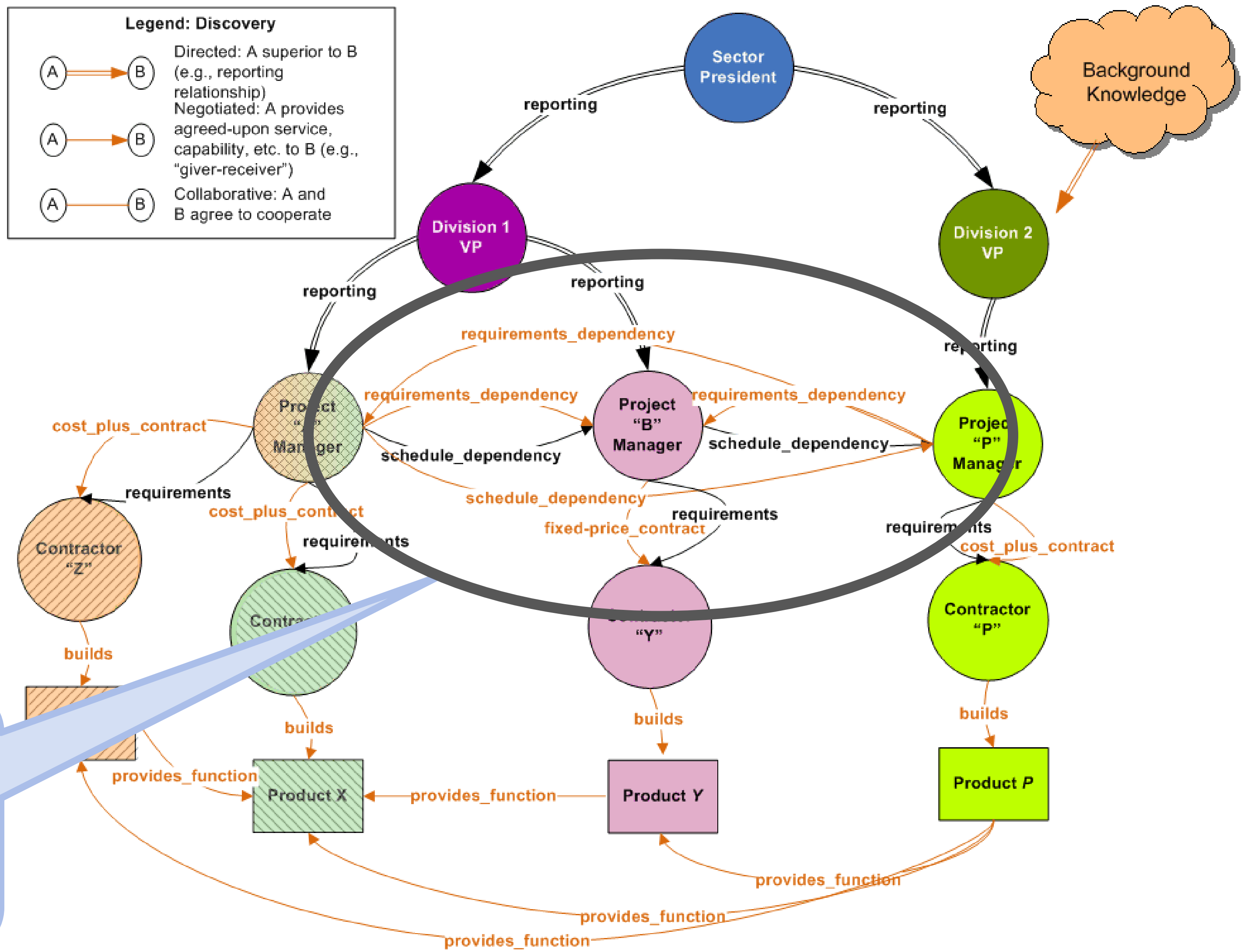
Context-Centric Influence Map

Provides a high-level, overview of entire system-of-systems context

- Includes major participants and influence relationships that comprise the key technical and programmatic drivers

Elaborates/updates the strawman context-centric IM based on information gained during interviews

Example: Context-Centric IM



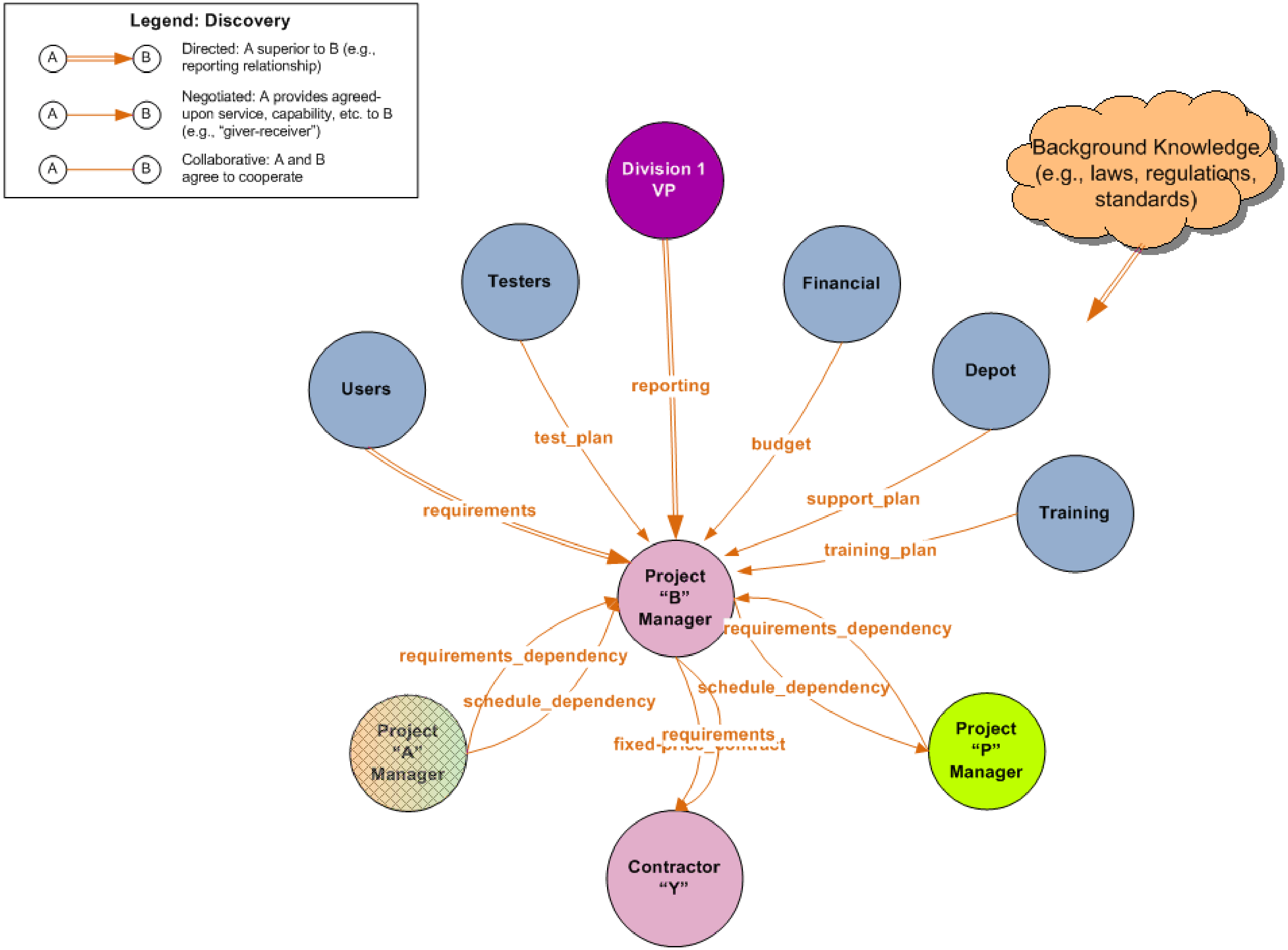
Note greater detail and additional relationships when compared to strawman context-centric IM

Node-Centric IM

Represents a view of immediate influence relationships (i.e., not via an intermediary agent/agency) from the perspective of a particular participant

Developed for each node (e.g., participant, organization) in a given SoS context

Example: Node-Centric IM



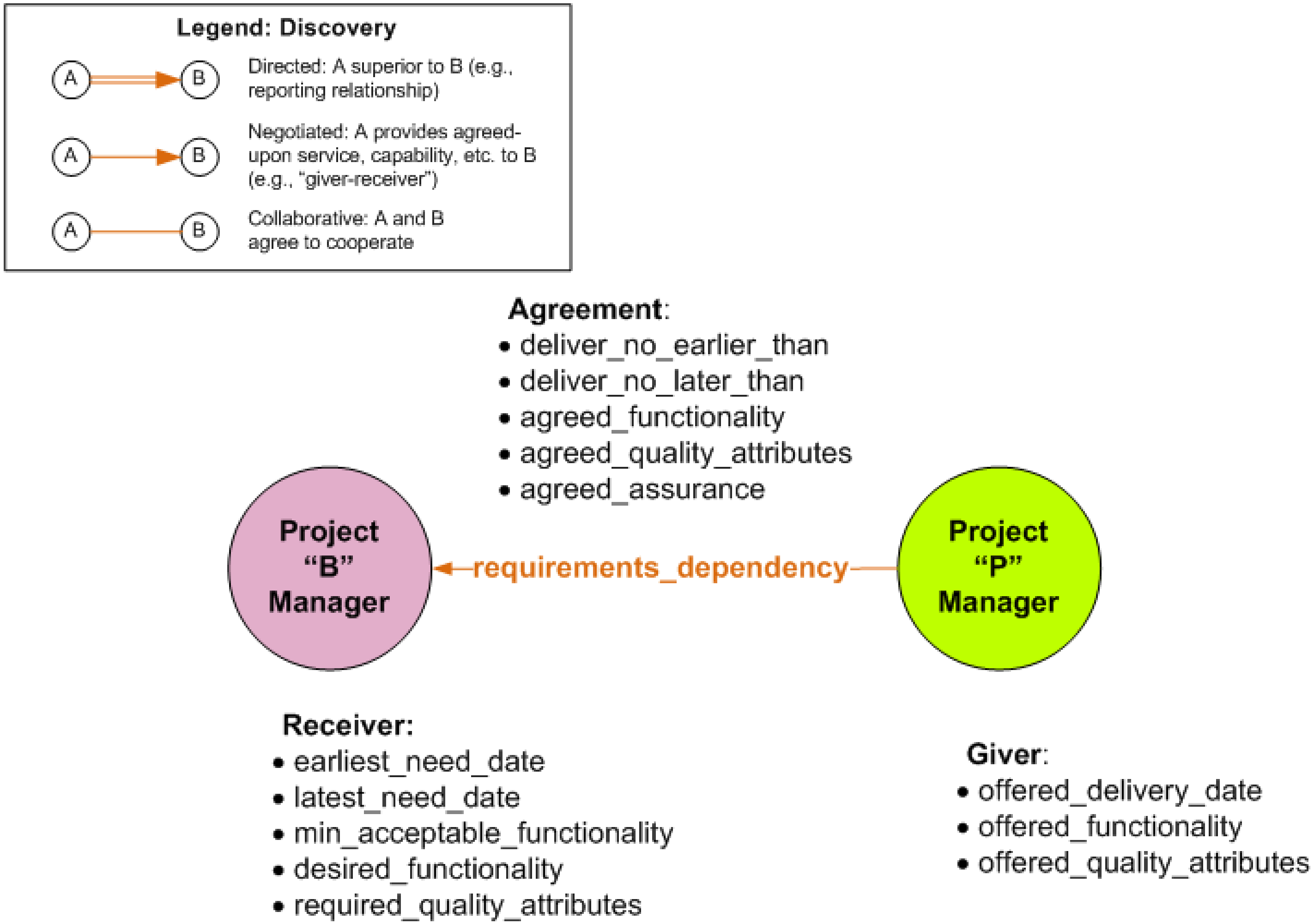
Agreement-Centric IM

Provides detailed representation of an individual influence relationship

- Includes semantics of the relationship
- Example: what—exactly—does “delivered” mean?
  - Installed and ready to turn on?
  - Or, shrink-wrapped, on a pallet, in some loading bay?

Developed for influence relationships identified as most critical to success in given SoS context

Example: Agreement-Centric IM



Analysis

Identify potential influence interrelationship risks

Characteristics of analysis approach

- IMA team compares the IMs developed during the preparation and discovery steps to identify and characterize
  - Differences with respect to the strawman IMs
  - Differences between participants' perspectives of a given influence relationship
  - New, changed, deleted, or missing influence relationships
- Analysis is performed from 3 perspectives
  - Context-centric
  - Node-centric
  - Agreement-centric
- IMA team members use identified patterns of influence relationships

Context-Centric IM – Analysis -1

Provides a composite of top-down context-centric IM developed during interviews, overlaid with individual node-centric IMs

Highlights divergent perceptions of influence relationships obtained during interviews

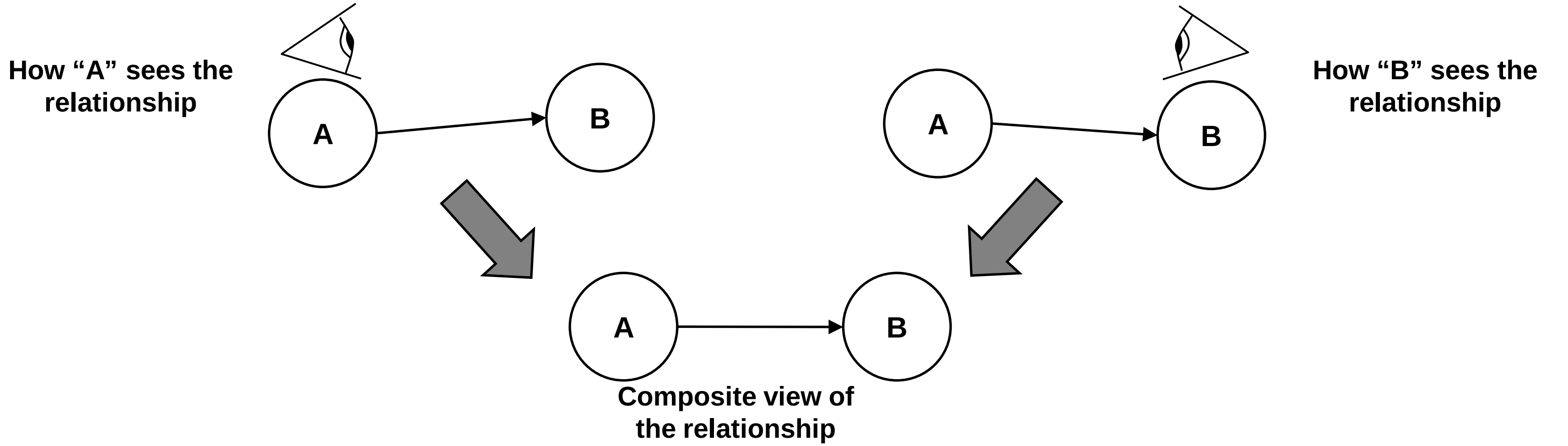
- New, or “discovered” influence relationships (i.e., influence relations not apparent from context-centric, top-down perspective)
- Deleted influence relationships, that appear in a context-centric view, but not at the node-centric perspective
- Conflicted influence relationships, for which different participants have divergent interpretations

Provides input to node IM – analysis and risk mitigation planning

Context-Centric IM – Analysis -2

Three-step process for construction of "analysis" IMs:

1. "Normalize" the IMs developed during discovery phase
   – Common naming scheme (i.e., resolve synonyms/homonyms)
   – "Apples-to-apples" comparison of relationship characteristics (e.g., schedule-to-schedule, functionality desired-versus-promised)
2. Prepare a composite IM at the appropriate level (i.e., context, node, or agreement)
   – Overlay different stakeholders' views

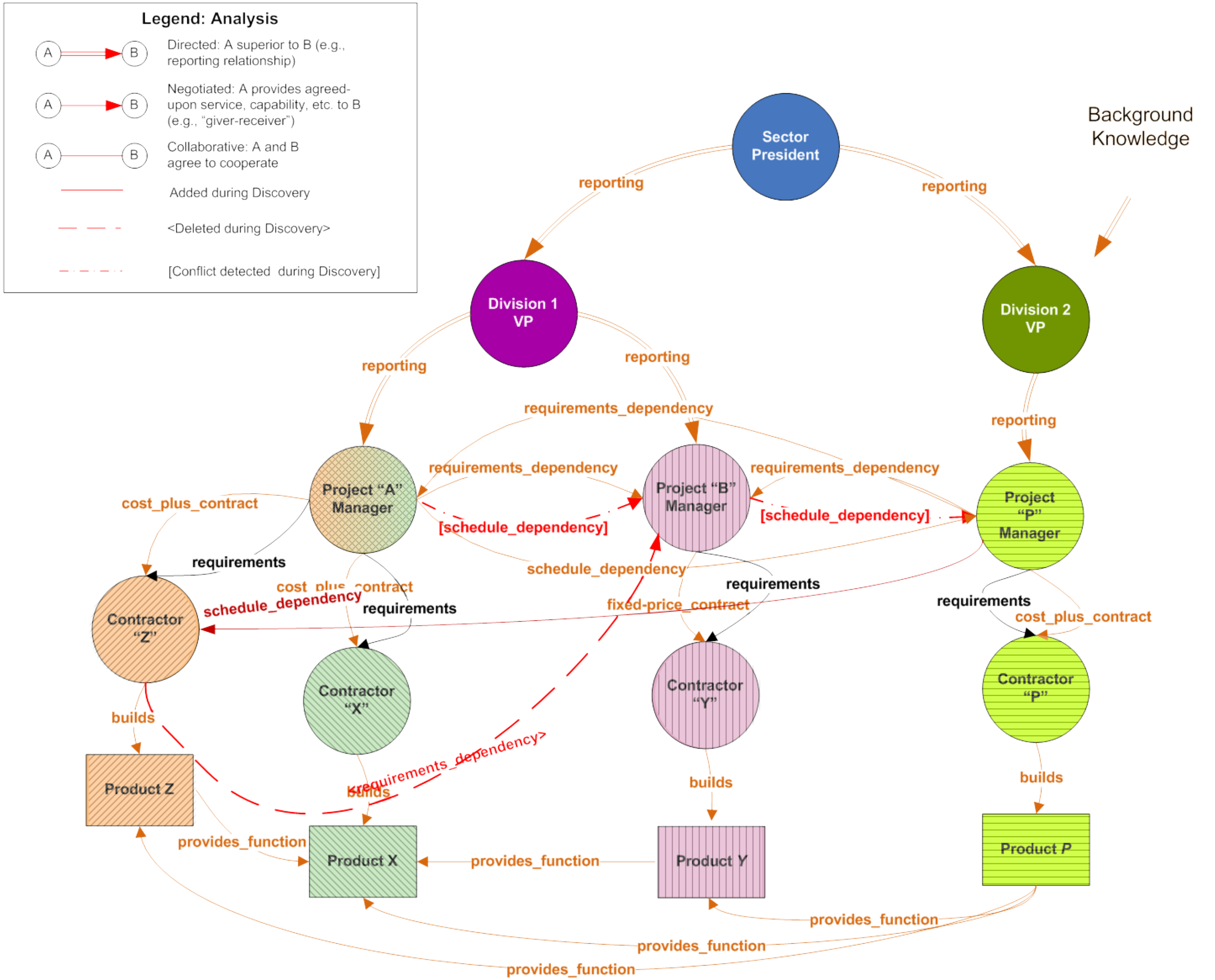


Context-Centric IM – Analysis -3

Three-step process for construction of “analysis” IMs (continued):

3. Examine the resulting composite IMs, highlighting any omissions, conflicts, or differences of interpretation on a relationship-by-relationship basis. For example:
   – Do both stakeholders participating in a given relationship “see” the same thing? For example, do both parties in a “giver-receiver” relationship agree on the delivery date? What they even mean by “delivered”? The required functionality? How that functionality will be assured?
   – Does only one stakeholder perceive the existence of a relationship? Are the stakeholders “talking past each other”?
     - Does one stakeholder perceive the relationship as a schedule dependency, while the other one sees a backwards-compatibility relationship?
     - They could both be referring to the same relationship, but their respective reference frames could prevent them from realizing that these relationships are—in fact—the same

Example: Context-Centric IM – Analysis



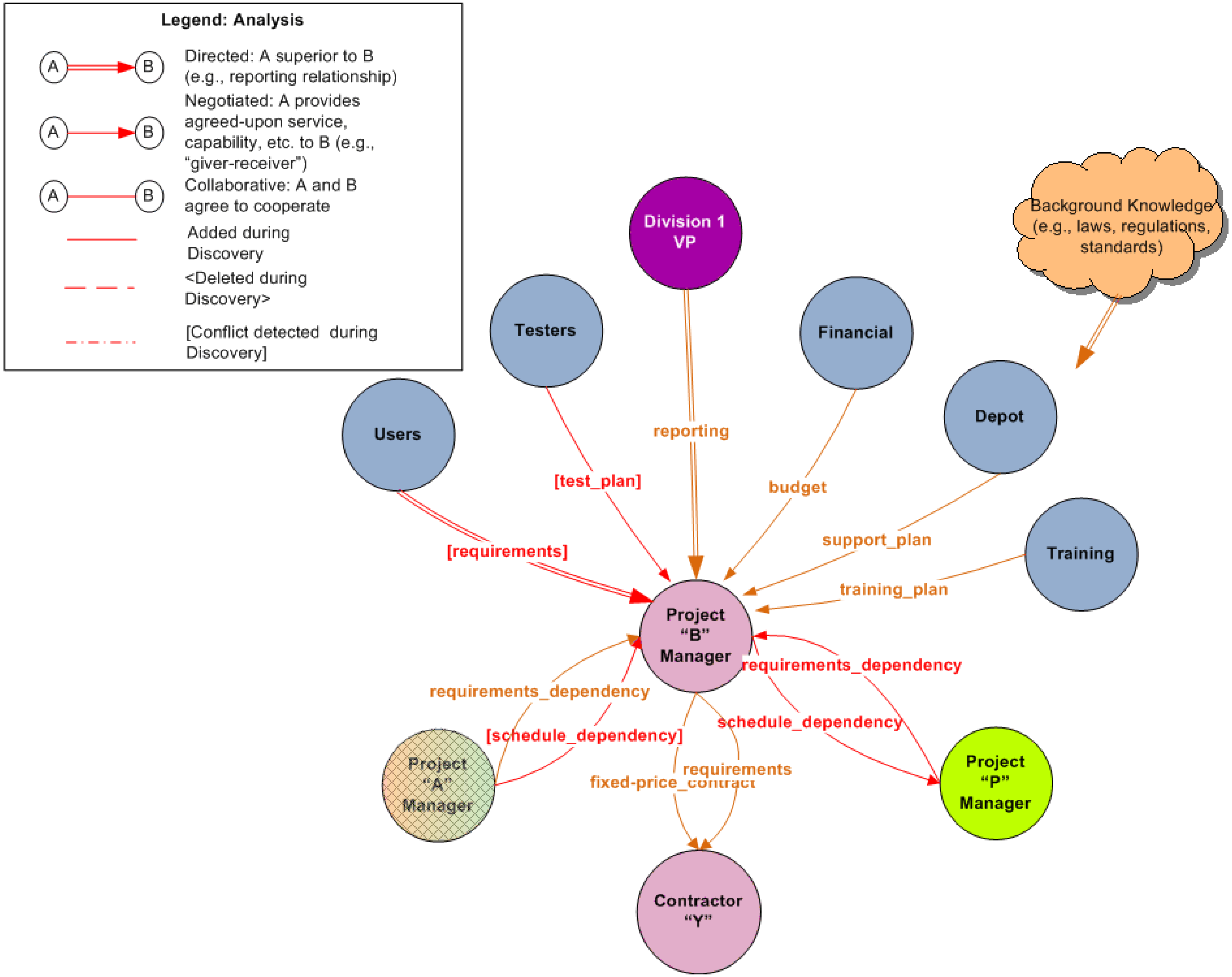
Node-Centric IM – Analysis

Characterize divergent perceptions of influence relationships

- Refinement of the context IM – analysis
- Captures/identifies top-level changes, additions, deletions, and conflicts for relevant influence relationships
- Supports prioritization of relationships requiring detailed analysis at agreement-centric level

Provides inputs to risk mitigation planning

Example: Node-Centric IM – Analysis



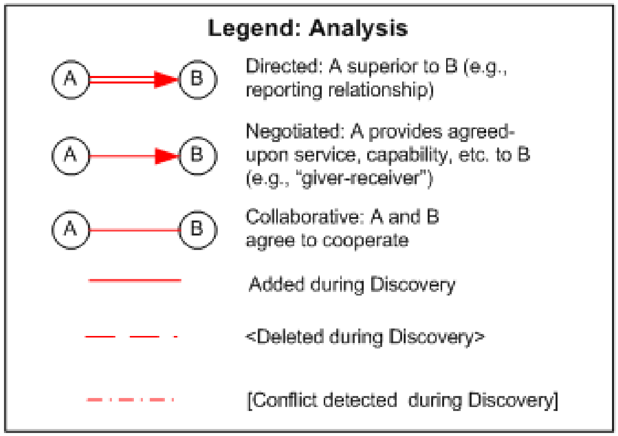
Agreement-Centric IM – Analysis

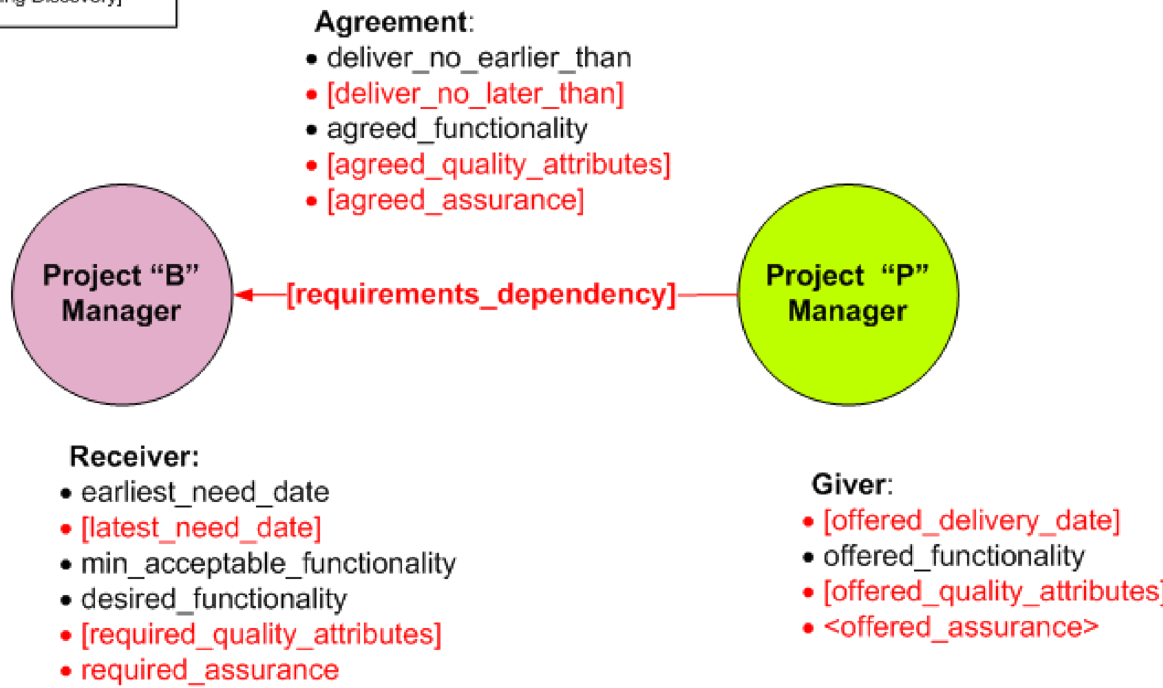
Captures detailed enumeration of changes, additions, deletions, and conflicts at the individual agreement level

- How has an agreement changed?
- What is the impact of that change?

Provides input to risk mitigation planning

Example: Agreement-Centric IM – Analysis





Mitigation Planning

Mitigation strategy and plans developed for prioritized risks identified during analysis phase

- Develop and implement mitigation strategy and plans in facilitated workshop
- Monitor for any changes
- Maintain and update IMs

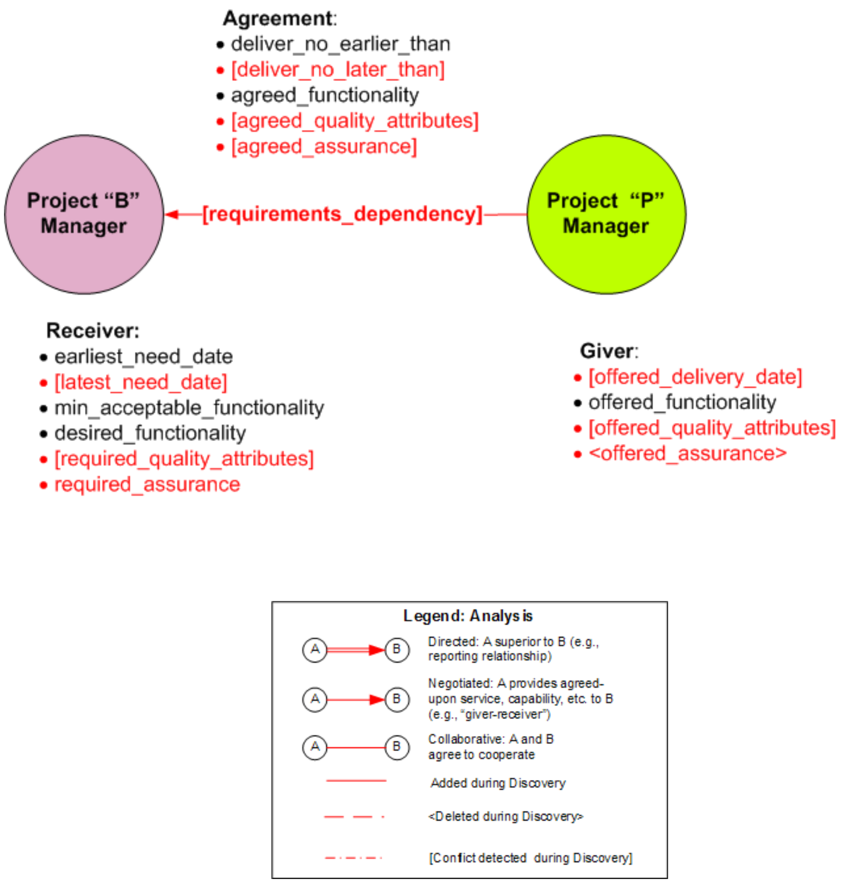
Example: Mitigation of Requirements Risk Identified in Analysis Agreement-Centric IM

Analysis identified changes in the requirements dependency between “P” and “B”

- Changes to “need” and “delivery” dates, and desired/offered quality attributes
- “B” has articulated new requirements for assurance, while “P” has dropped some previously-offered assurances

Analysis provides a basis for “B” and “P” to negotiate a new agreement—or identify that no agreement is possible

Identified aspects of the agreement—which may have been previously unstated— that need to be watched for future changes (e.g., quality attributes) based on their potential to affect cost, schedule, or performance



SUMMARY

Key Points

Conventional governance and acquisition techniques and processes provide an incomplete, and often incorrect, understanding of how the dynamics of systems of systems bear on the eventual success or failure of the enterprise

IMs—and associated IMA method:

- Permit identification of disconnects between stakeholder perspectives of influence interrelationships, and deviations from "official truth"
- Is useful for any organization involved in systems of systems with multiple stakeholders, and conflicting goals
  - Particularly relevant for program managers, senior executives, and policy makers
- Provides sufficient detail for focused mitigation actions

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Advancing Systems Engineering Practice Using Model Based Systems Development

October 29, 2009

LOCKHEED MARTIN

Sanford Friedenthal

Lockheed Martin

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Topics

- Model-based Systems Development Motivation, Scope, and Challenges
- MBSD Approach Using System Architecture Model as Integration Framework
- MBSD Observations
- INCOSE MBSE Initiative
- Summary

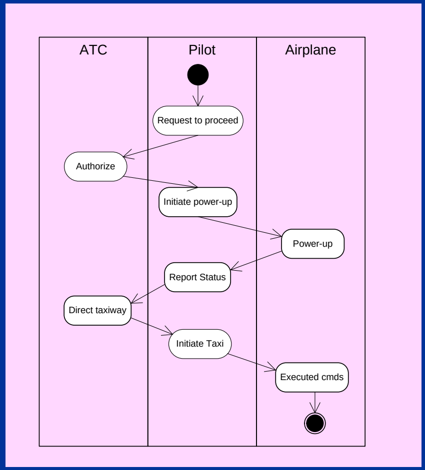
MBSD Motivation, Scope, and Challenges

SE Practices for Describing Systems

Past

- Specifications
- Interface requirements
- System design
- Analysis & Trade-off
- Test plans

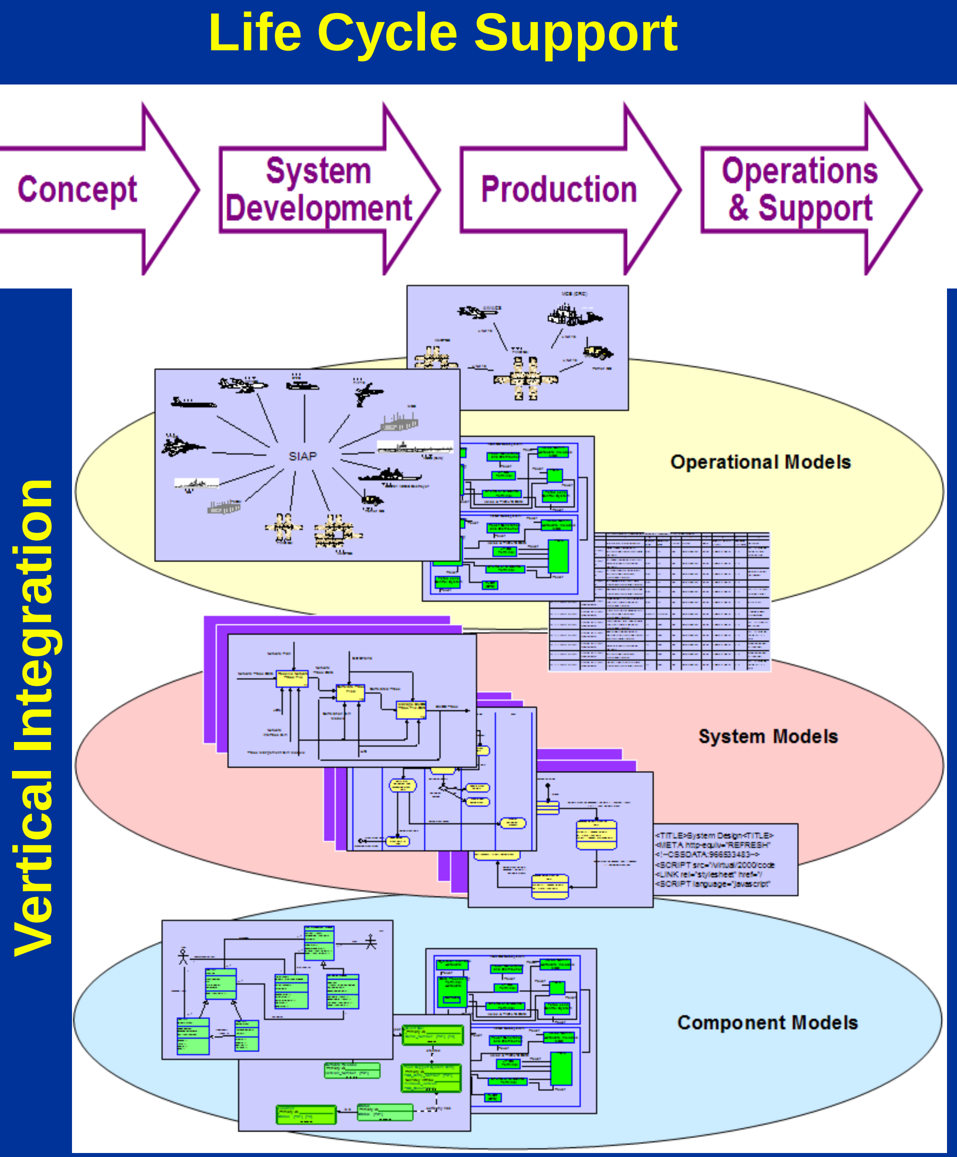
Future



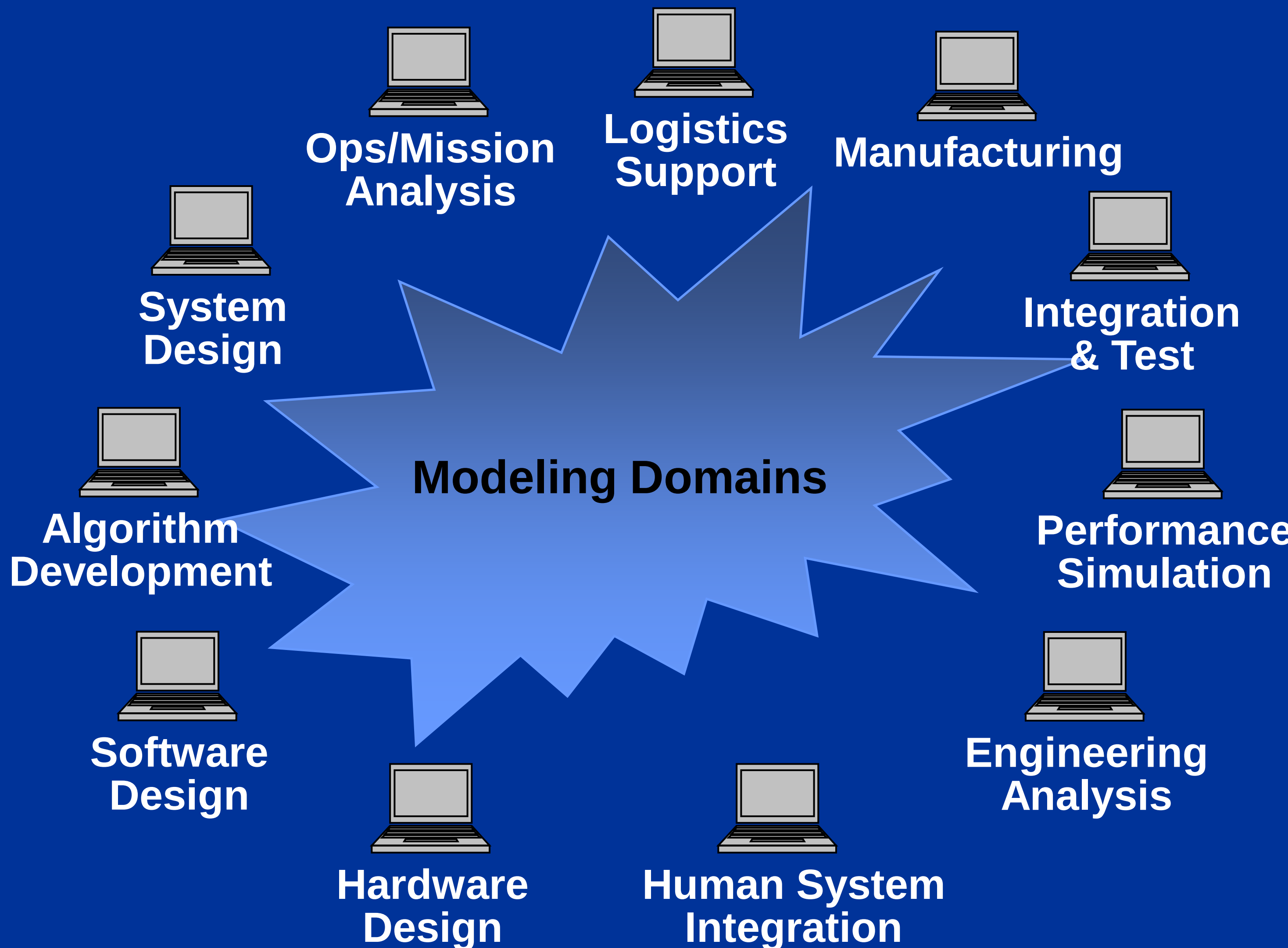
Moving from Document centric to Model centric

Model-based Systems Development (MBSD)

- **Formalizes the practice of systems development through use of models**
- **Broad in scope**
  - Integrates with multiple modeling domains across life cycle from system of systems to component
- **Results in quality/productivity improvements & lower risk**
  - Rigor and precision
  - Communications among system/project stakeholders
  - Management of complexity



MBSD Must Integrate across Modeling Domains

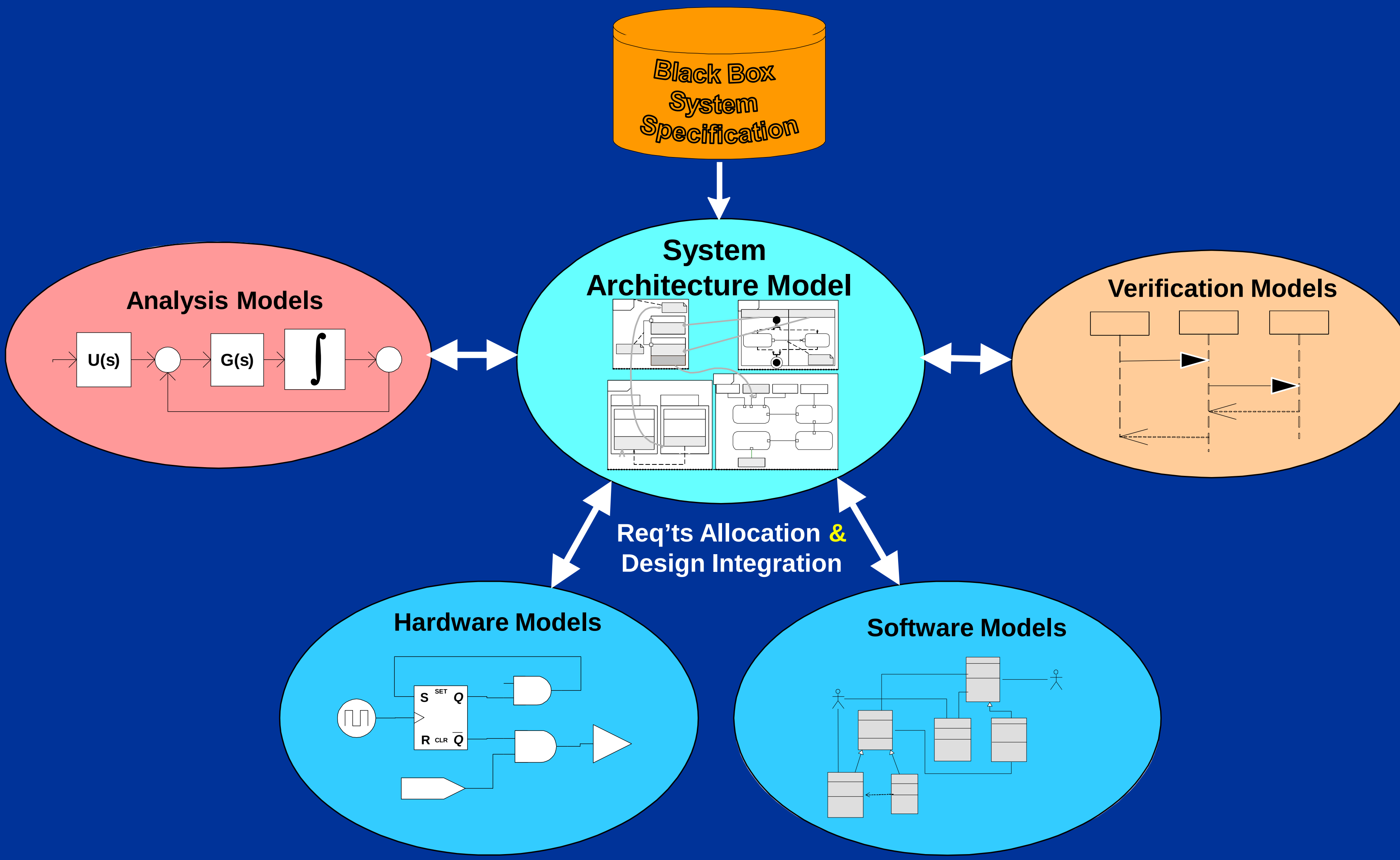


Modeling Challenges

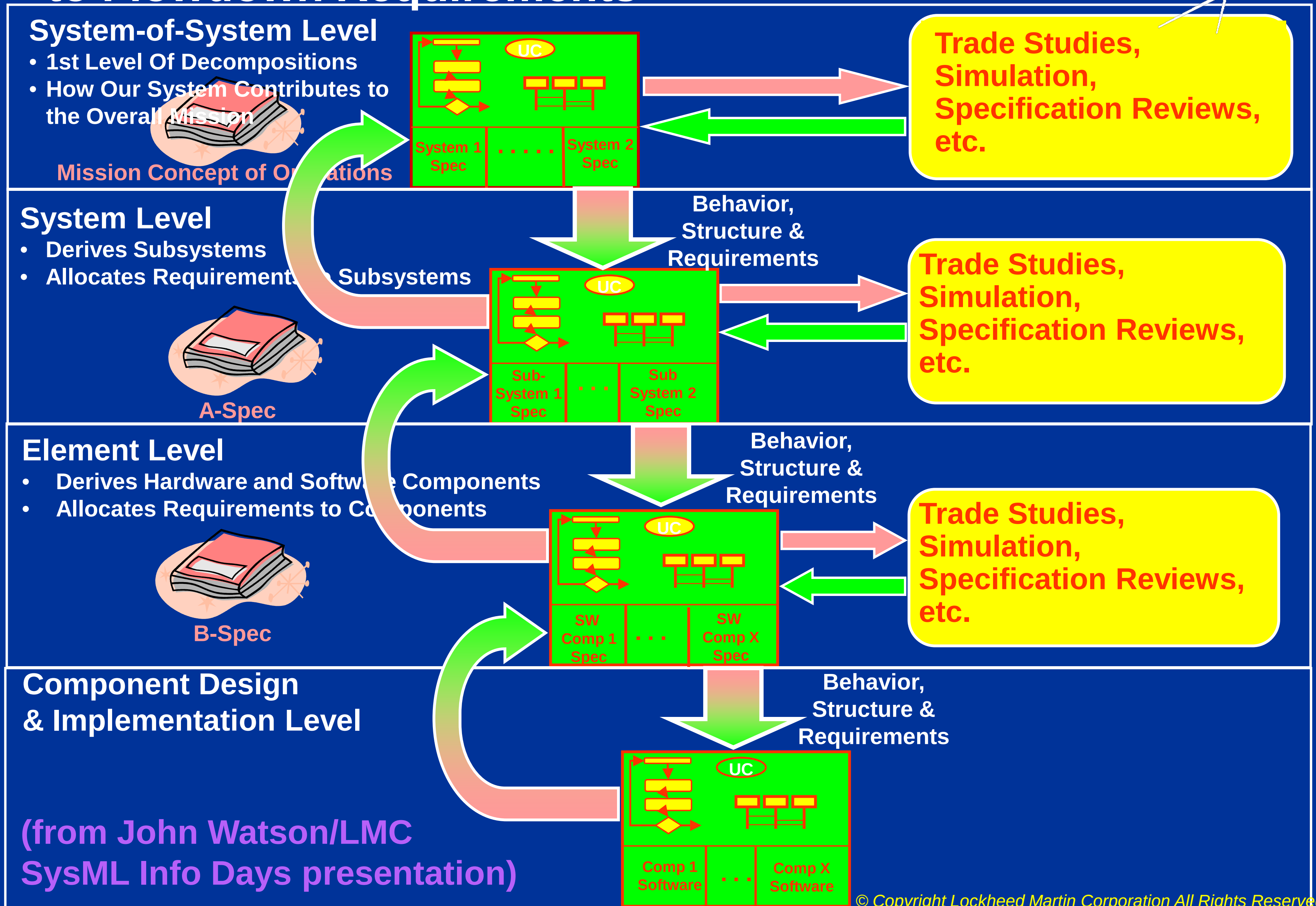
- **Lots of good modeling going on, but:**
  - Modeling practices in people's head, and not well codified and shared
  - Modeling still done in stovepipes, and not fully integrated into systems development workflow

MBSD Approach Using System Architecture Model as Integration Framework

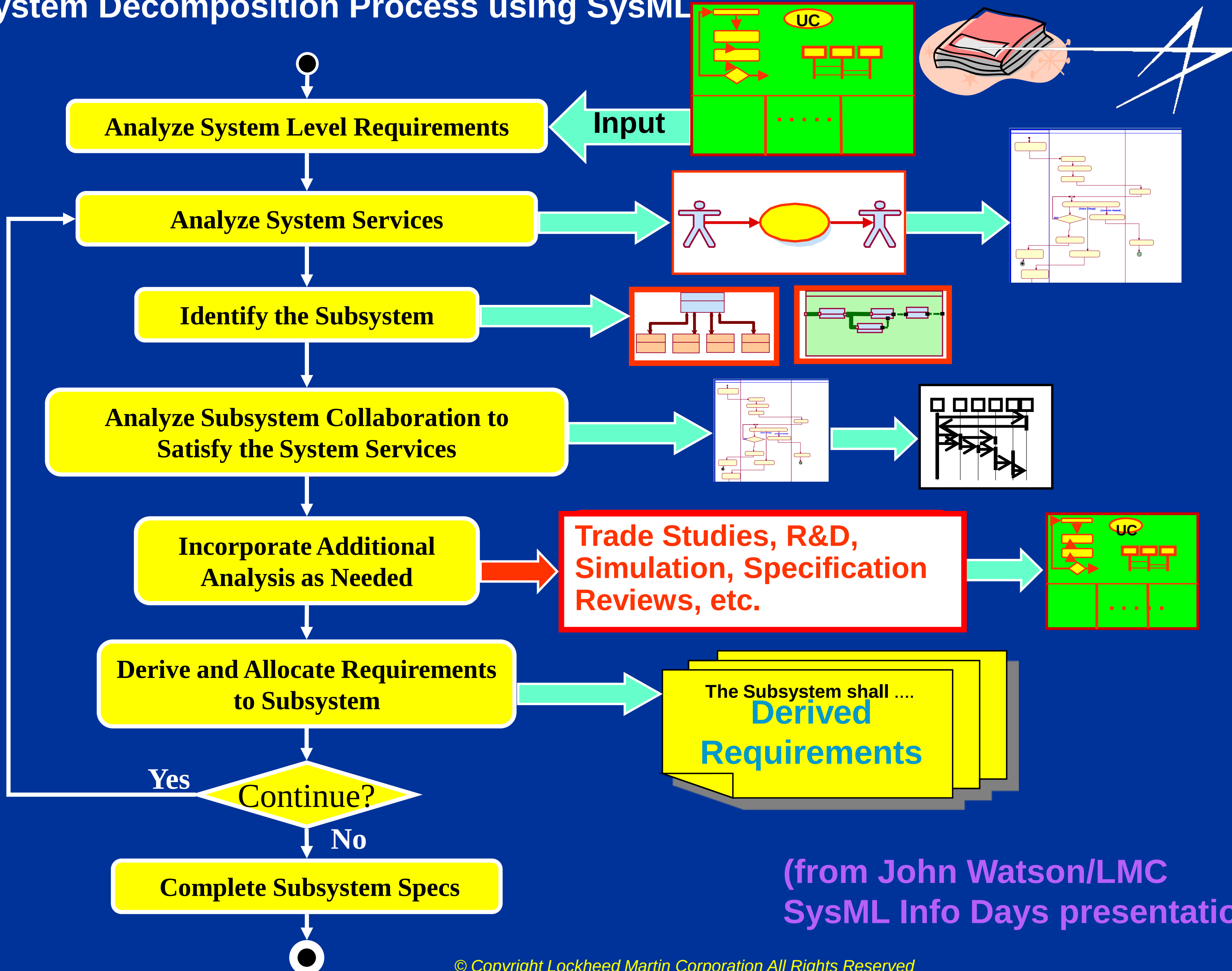
Using System Architecture Model as an Integration Framework



Using the System Architecture Model to Flowdown Requirements

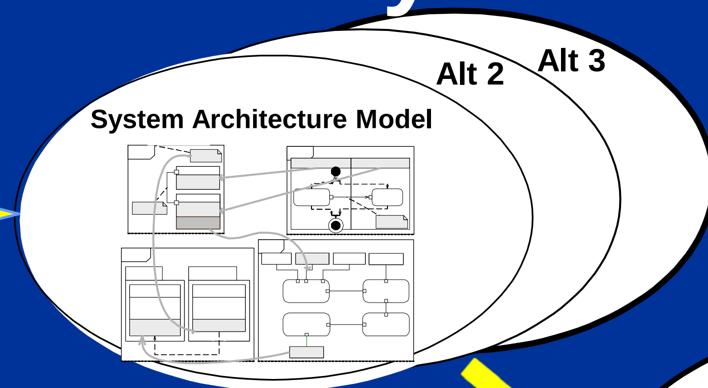


System Decomposition Process using SysML



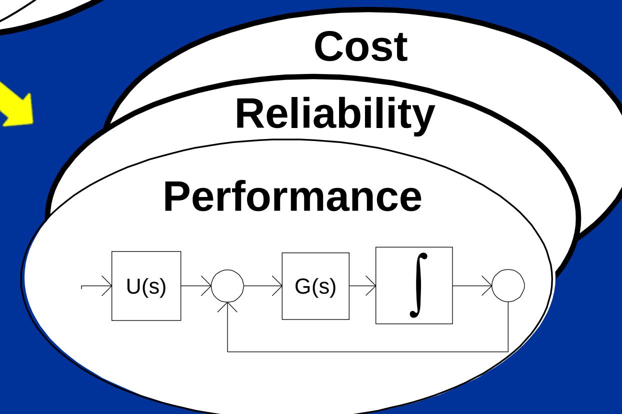
(from John Watson/LMC SysML Info Days presentation)

System Architecture Model to Support Tradeoff Analysis

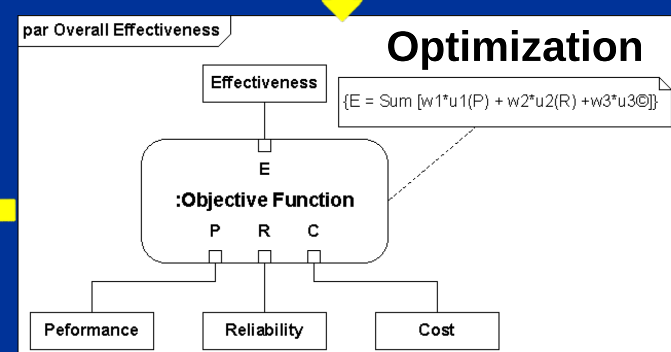


Analysis Results

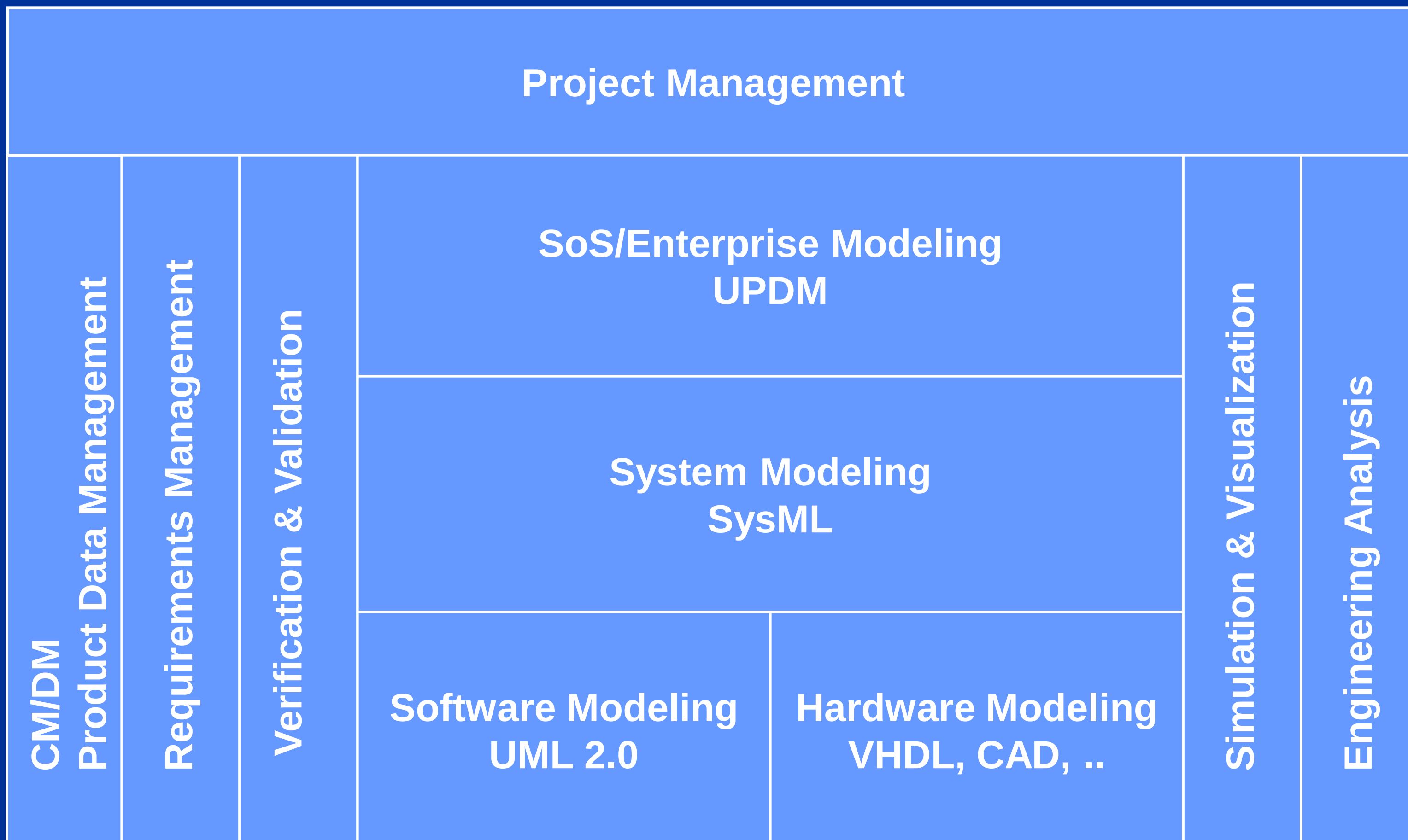
Subsystem	Alternative1	Alternative2	Alternative3
Sensor	Sensor1	Sensor2	Sensor3
Processor	Processor1	Processor2	Processor3
Control	Control1	Control2	Control3



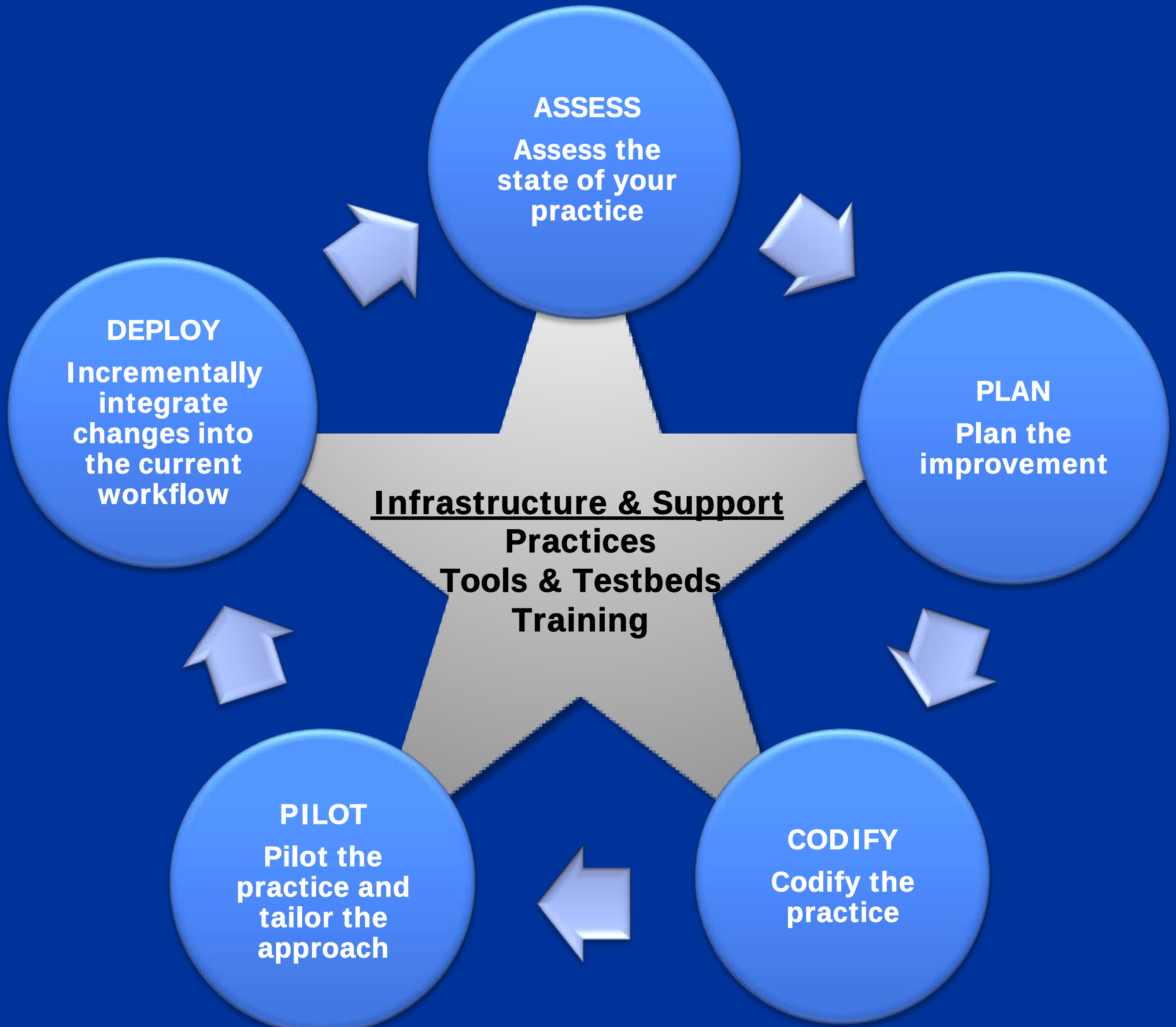
Criteria	Weight	Alt 1	Alt 2	Alt 3
Performance	0.5	7	5	5
Reliability	0.2	4	6	5
Cost	0.3	3	5	8
Effectiveness		5.2	4.2	**5.9**



Typical Integrated Tool Environment



Deploying MBSD as part of Improvement Process



Observations and Summary

MBSE Observations

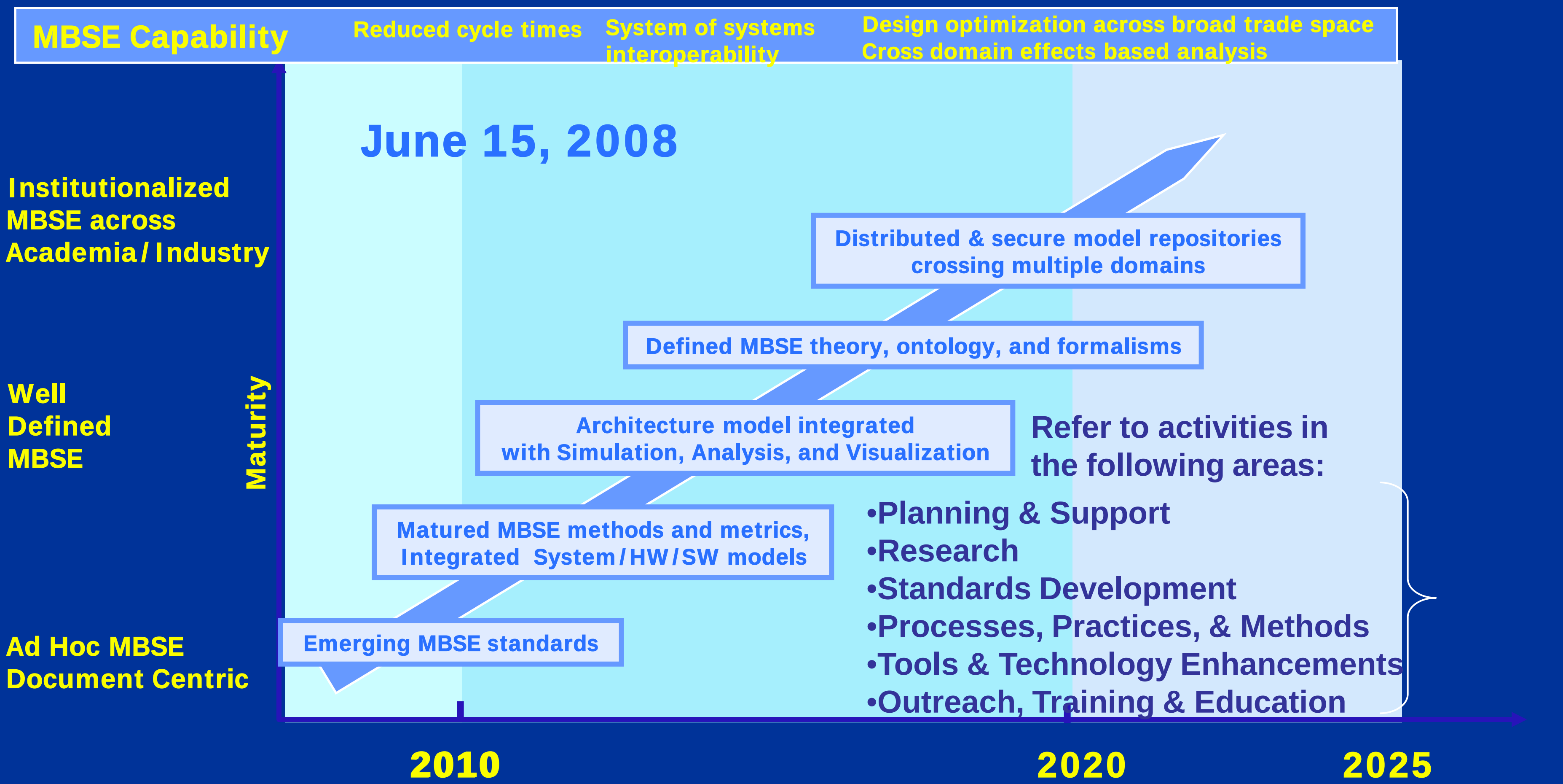
- **Transition from document-centric to model-centric is a cultural change**
- **Well defined MBSE method is essential**
- **Multiple tool vendors provide a range of price point, capability, and standards conformance**
- **MBSE training should include language, method, and tools**
- **Employ pilots to validate your MBSE approach**
- **Need buy-in from program and customer on MBSE benefits, approach and deliverables**
- **Scope model to support program objectives and within program constraints**
- ***A lot has been learned, but much more remains***

INCOSE MBSE Initiative

INCOSE MBSE Initiative Charter

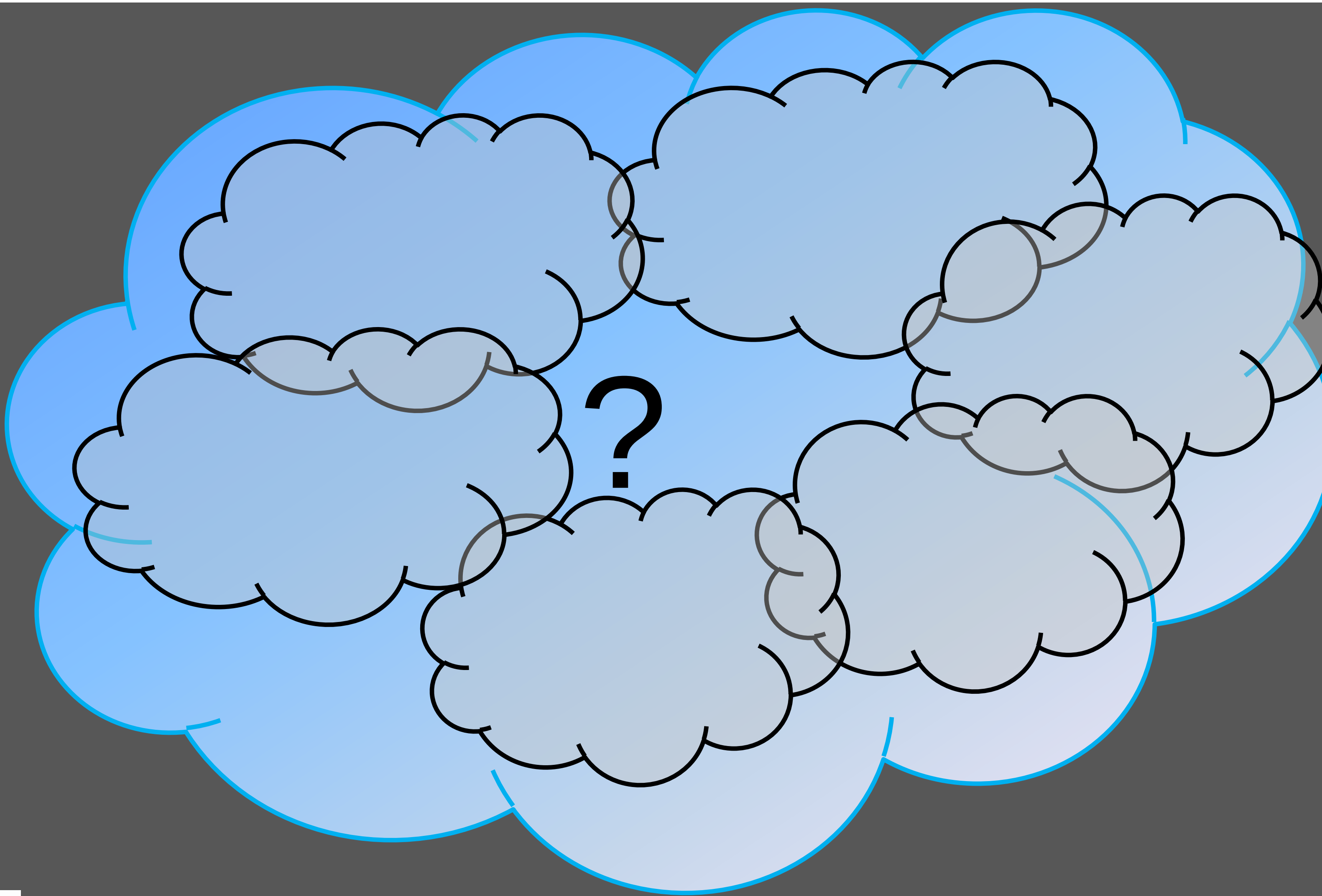
- **Promote, advance, and institutionalize the practice of MBSE to attain the MBSE 2020 Vision through broad industry and academic involvement in:**
  – Research
  – Standards
  – Processes, Practices, & Methods
  – Tools & Technology
  – Outreach, Training & Education

INCOSE MBSE Roadmap



Summary

- MBSE is a key practice to advance complex systems development
- Standards such as SysML are critical enablers of MBSE
- Multiple tool vendors implementing the standard
- System architecture model and standards based approach facilitate Integration across modeling domains
- Growing interest and application of MBSE
- INCOSE MBSE helping to advance and promote MBSE



RDECOM

TARDEC

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

A Systems Engineering Model for Roadmap Alignment

Presented by: Si Dok
Prepared by:
Si Dok, Harsha Desai, and John Fitch

October 2009

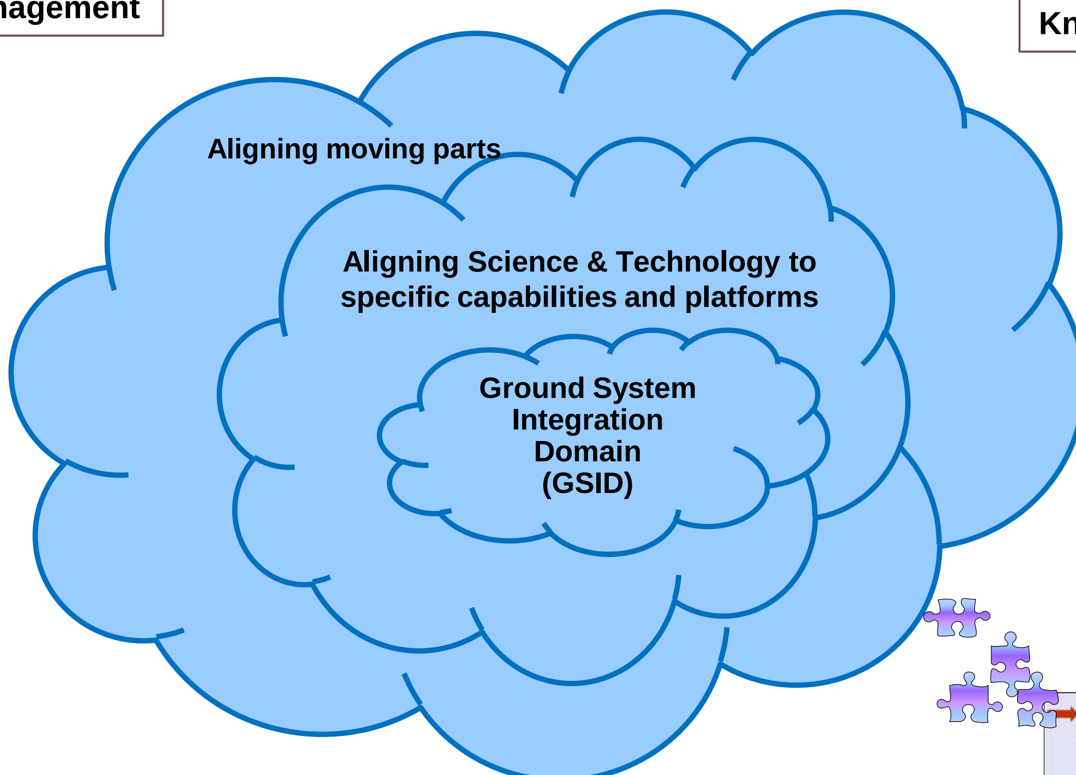
INTRODUCTION

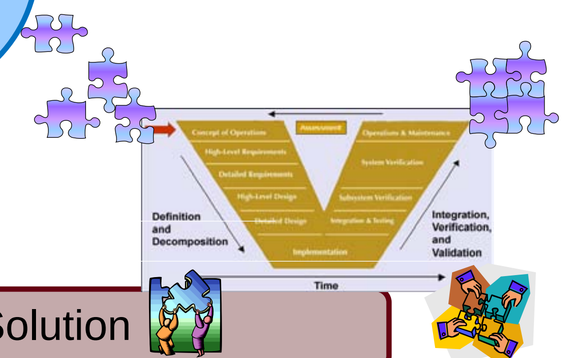
1. Discuss problem space
2. Discuss condition of problem space
3. Discuss affinity process
4. Discuss architectural function
5. Roadmap alignment

Things evolve at their own rate!

Information Management

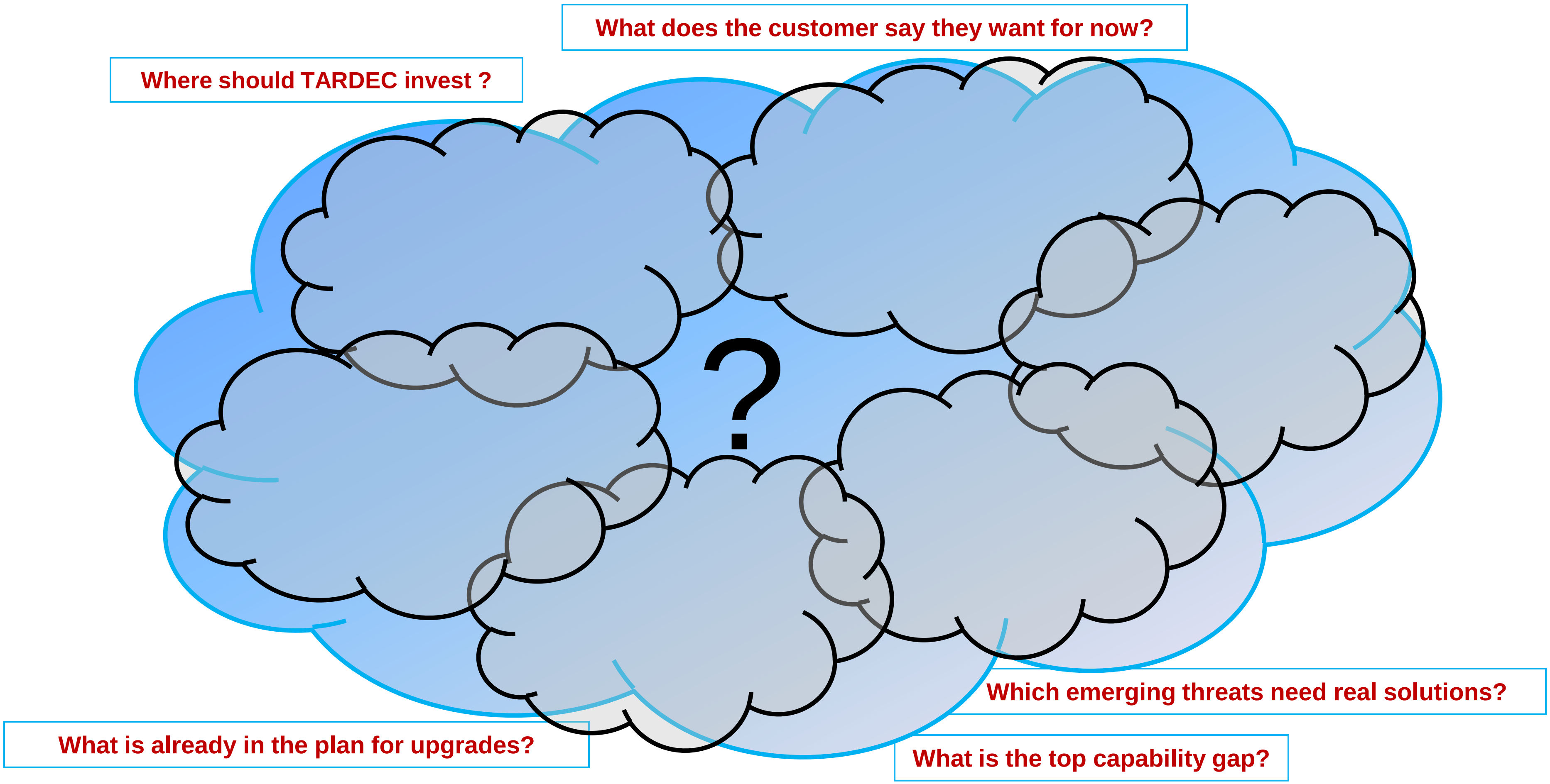
Knowledge Engineering





"We Systems Engineered Our Own Problem Solution

TARDEC PROBLEM - CURRENT SCENARIO



Things do not align themselves!

TARDEC PROBLEM - CURRENT SCENARIO

Things do not align themselves!

DEVELOPING THE FRAMEWORK

Defining the Taxonomy | **Functions**

- Informs S&T Portfolio Decisions
  - Maintain Warfighter Needs
    - Provide context for capability needs
    - Plan capability evolution
    - Identify capabilities gaps
    - Prioritize capabilities gaps
    - Identify enabling technologies
      - Time-align capabilities and enabling technologies
      - Performance-align capabilities and enabling technologies
    - Identify common needs
    - Refine capabilities needs
  - Maintain RDECOM technology/solution taxonomy
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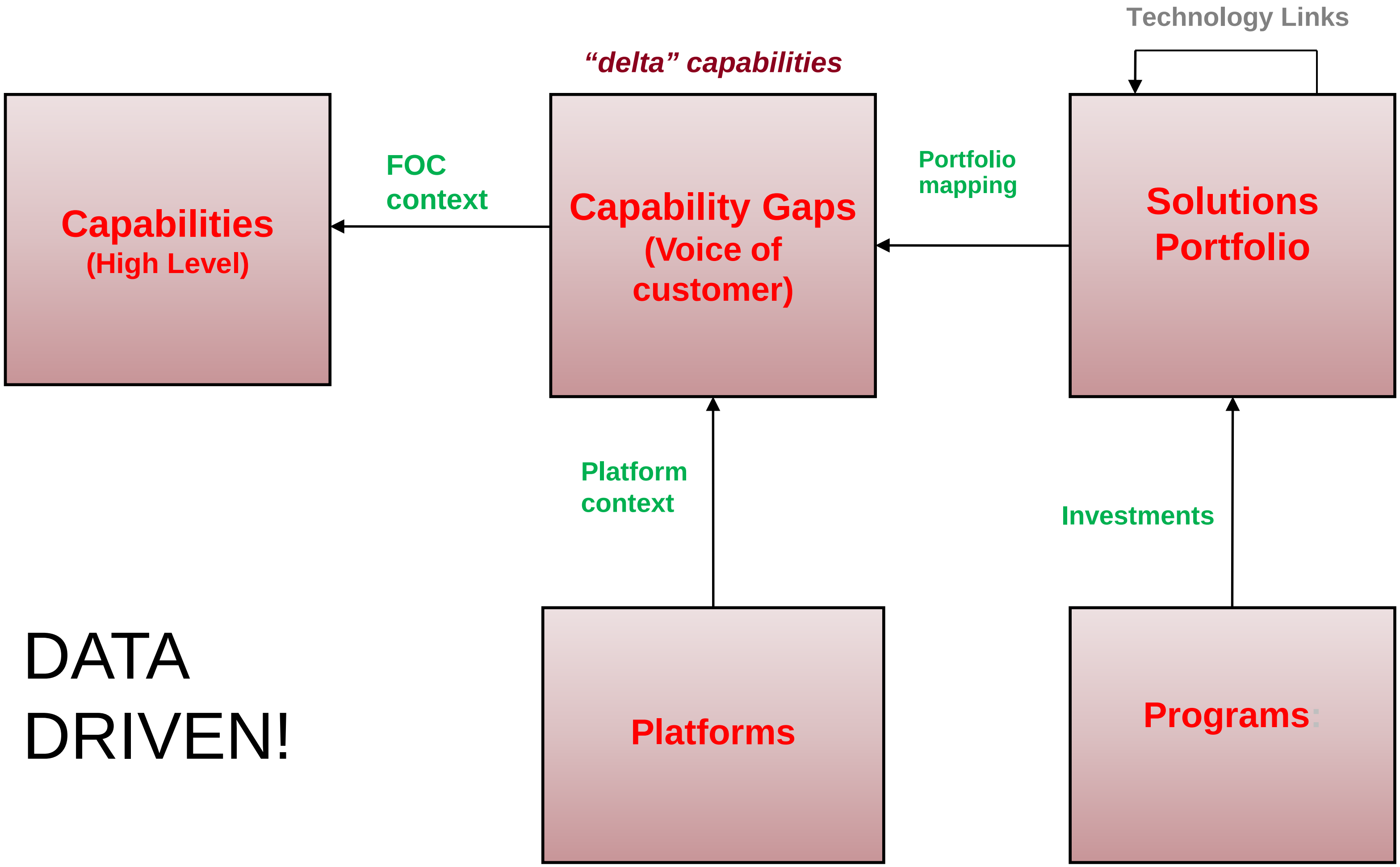
  - Maintain platforms taxonomy
    - Plan platform evolution
    - Allocate capabilities to platform upgrades
  - Capture S&T program portfolio
    - Plan programs
    - Re-plan programs
    - Track program status

OUR STRUCTURED APPROACH LEADS TO STABILIZATION



DATA
DRIVEN!

FUNCTIONAL ARCHITECTURE

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Data Elements

- CAPABILITY
- VOICE OF CUSTOMER
- PLATFORM
- TECHNOLOGY
- PROGRAMS

BALANCING

Market "Pull"……………………………………………..Technology "Push"

War fighter Needs
Capability Gaps
- *Prioritize*
- *Identify Common*
- *Decompose*

Batch/Event Driven

Technology Focus Areas
- *Power and Energy*
- *Mobility & Logistics*
- *Lethality*

Requirements "Model"
- Functional
- Performance
- Platform Constraints

Continuous
Ownership model

Technology Roadmap
- Functional
- Performance
- Platform Constraints

Function
KPP
SWaP
Platform
Cost

ALIGN

Function
KPP
SWaP
Platform
Cost

ROADMAP CONCEPT

Decisions:
D1: What is our vehicle/platform roadmap? Which capability gaps will be filled in which increments (customer)
D2: What capability gaps will TARDEC attempt to fill? With which technologies and solution sets? (TARDEC)
D3: How will we integrate our technology enablers into high-value (multi-use) solution sets? (TARDEC)
D4: What portfolio of programs (investments) will best deliver the technologies and solutions that meet the warfighters' needs? (TARDEC)

Platforms

Veh X
SWaP
Cap's

Veh Y
SWaP
Cap's

Gather existing Vehicle roadmaps, capabilities allocated to increments and SWaP constraints

D1

Capabilities

Cap A
KPP 1
KPP 2
KPP 3

Cap B
KPP 1
KPP 2

Identify opportunities by analyzing PM 1-N lists, TFT Tech Gaps and WFOs

Decompose capability gaps into functions and KPPs using source requirements documents (due diligence to confirm alignment)

D2

Solutions

Sol 1
KPP 1
SWaP
TRL

Sol 2
KPP 1
SWaP
TRL

Wire together technology enablers to form solution sets

D3

Technologies

Tech 1
KPP 1
KPP 2
TRL

Tech 2
KPP 1
KPP 2
TRL

Gather and refine existing roadmaps + technologies ideas from SMEs

Gather summaries of existing ATOs, SBIRs, Congressional Adds and identify their deliverables in terms of technology maturation (KPPs + TRLs)

D4

Programs

SUMMARY

1. Everyone will fall into one of the alignment realms

2. Using non-conventional SE processes

3. Anything can be aligned

4. Structured information model - ready-for-use pattern

Q&A Session

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CAPABILITY

VOICE OF CUSTOMER

PLATFORM

TECHNOLOGY

PROGRAMS

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Overview of Department of Defense (DoD) Software Engineering Initiatives

Mr. Scott Lucero

Deputy Director, Software Engineering

Systems Engineering Directorate
Office of the Director, Defense Research and Engineering

12th Annual NDIA Systems Engineering Conference
October 29, 2009

Elements of a DoD Strategy for Software Engineering

- **Support Acquisition Success**
  – Ensure effective and efficient software solutions across the acquisition spectrum of systems, SoS and capability portfolios
- **Improve the State-of-the-Practice of Software Engineering**
  – Advocate and lead software initiatives to improve the state-of-the-practices through transition of tools, techniques, etc.
- **Leadership, Outreach and Advocacy**
  – Implement at Department and National levels, a strategic plan for meeting Defense software requirements
- **Foster Software Resources to meet DoD needs**
  – Enable the US and global capability to meet Department software needs, in an assured and responsive manner

Promote World-Class Leadership for Defense Software Engineering

NDIA Top Software Issues September 2006

1. The impact of requirements upon software is not consistently quantified and managed in development or sustainment. **"SW Requirements"**
2. Fundamental system engineering decisions are made without full participation of software engineering. **"SE/SW Integration"**
3. Software life-cycle planning and management by acquirers and suppliers is ineffective. **"SW Sustainment"**
4. The quantity and quality of software engineering expertise is insufficient to meet the demands of government and defense industry. **"Human Capital"**
5. Traditional software verification techniques are costly and ineffective for dealing with the scale and complexity of modern systems. **"SW Testing"**
6. There is a failure to assure correct, predictable, safe, secure execution of complex software in distributed environments. **"SW Assurance"**
7. Inadequate attention is given to total lifecycle issues for COTS/NDI impacts on lifecycle cost and risk. **"SW COTS / NDI / Reuse"**

Top Software Issues - 2006 vs. Software Systemic Findings - 2008

National Defense Industrial Association (NDIA)
Top 7 Software Issues
September 2006

- Software Human Capital
- Software Requirements
- Systems/Software Integration
- Software Assurance
- Software Testing
- Software Sustainment
- Software COTS/NDI

ODDRE/SE Systemic Analysis of
Program Support Review Findings

Software Human Capital
- Resources
- Quality Level

Software Requirements
- Engineering
- Management
- Acquisition Strategy

Systems/Software Integration
- Systems of Systems
- Interoperability
- Tech Refresh

Software Assurance

Software Development
- Software Testing*
- Software Sustainment/Maintenance*
- Software COTS/NDI*
- Technology Readiness
- Software Architecture

Software Metrics
- Software Metrics
- EVM

Software Engineering Management
- Project Planning
- Management Oversight
- Software Configuration Management

Knowledge Sharing
- Process
- Reporting

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Current Software Engineering Initiatives

- **Program Support**
  - Provide software support for acquisition program reviews. Develop independent schedule and defect estimates.
- **Human Capital**
  - Software Acquisition Training and Education Workgroup: Establish SW competencies across the acquisition career fields
  - Reference Curriculum for Graduate Study of Software Engineering: Version 1.0 completed this month, to be sustained by IEEE and ACM.
- **Advance the State of the Practice**
  - Software Sustainment, NDIA Software T&E Summit/Workshop
- **Policy and Guidance**
  - Earned Value Management, Military Handbook for Work Breakdown Structures: MIL-HDBK-881.
  - Oversight of Services' SW Acquisition Process Improvement Programs.

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Notional Example of Schedule Feasibility Analysis

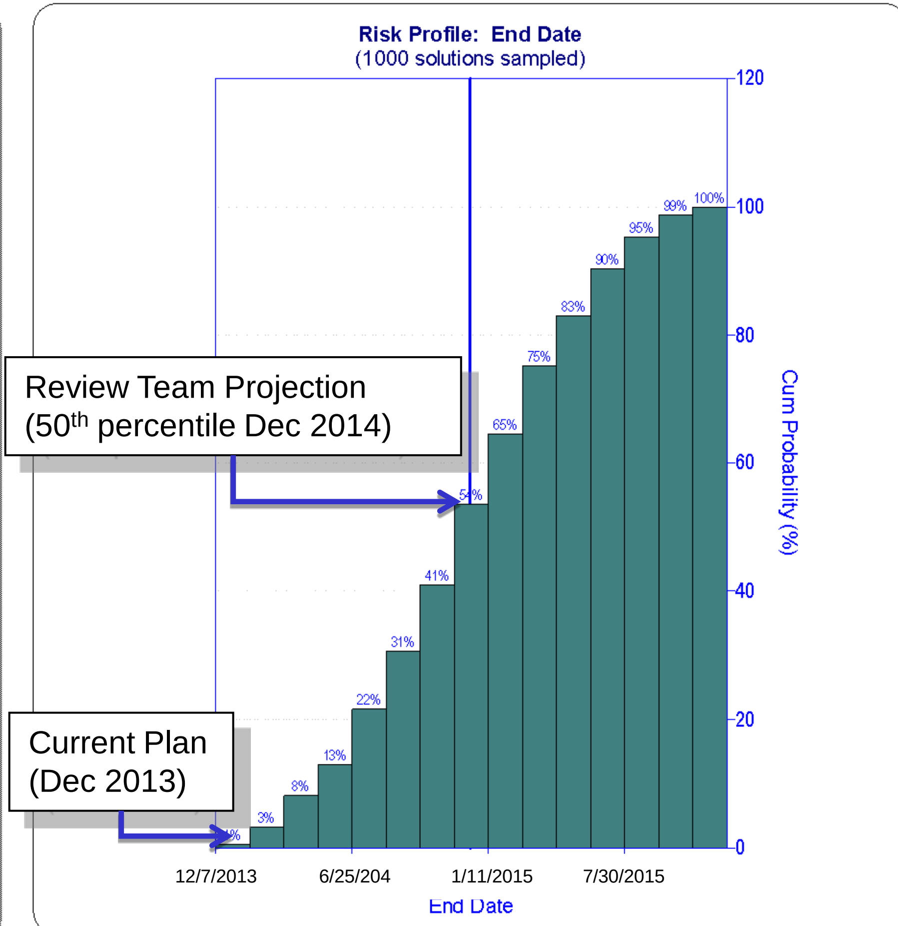
Current Plan (Dec 2013)

Risk Profile: End Date
00 solutions sampled)

End Date	Cum Probability (%)
1/26/2014	1
3/17/2014	3
5/6/2014	8
6/25/2014	13
8/14/2014	22
10/3/2014	31
11/22/2014	41
1/11/2015	54
[illegible]/2/2015	65
[illegible]/21/2015	75
[illegible]/10/2015	83
[illegible]/30/2015	90
9/18/2015	95
11/7/2015	99
12/27/2015	100

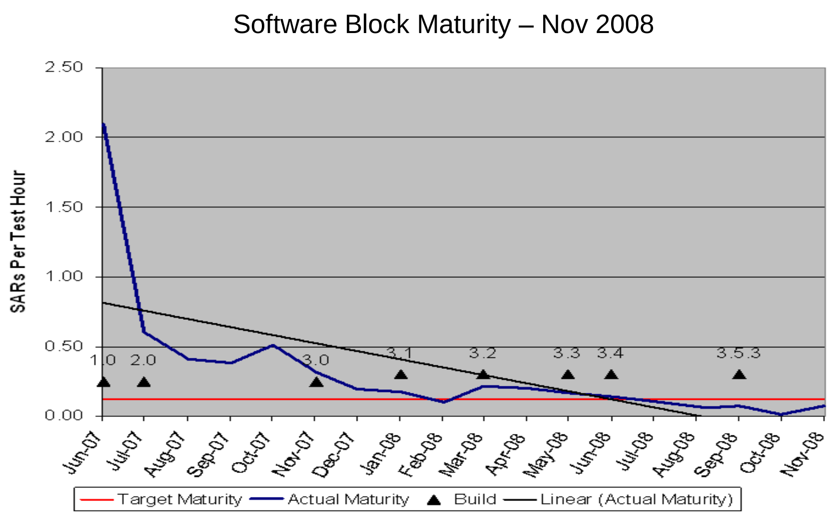
Review Team Projection
(50th percentile - Dec 2014)

Likelihood of delivery to current schedule: less than 1%



Software and Systems Reliability

- **DoD has renewed emphasis on systems reliability and lifecycle costs of shortfalls**
  – DDRE effort underway to consolidate software reliability guidance
- **Starting to use parametric models to project numbers of latent software defects and discovery rates**
  – Used to support:
  – Development of satellite launch plans
  – Aircraft production decisions
  – Operational test readiness reviews
- **Gauging software reliability using Mean Time to Defect (MTTD) discovery**



System Testing DRs / Test Hr
(DT events to IOT&E)

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Software Human Capital Efforts

Software Industrial Base Study – July 2007
There is a choke-point in availability of top-tier software managers, architects, and domain experts.
Supply of sufficiently trained SW developers is inadequate near-term.

- **Software Acquisition Training and Education (SATEWG)**
  - Chartered February 2008 by USD(AT&L) to add software competencies to DoD's 13 acquisition career fields
  - Recent accomplishments:
    - Developed software competency framework,
    - Established SPRDE software competencies
    - Gap analysis of SATEWG competency framework and DAU's Software Acquisition Management courses
    - Current focus is on PM, Contracting and Test career fields
- **Graduate Software Engineering Reference Curriculum (GSwERC)**
  - Partnership with Industry and Academia
  - Version 1.0 completed September 2009
  - Transitioned to IEEE and ACM for sustainment

Software Sustainment Challenges

- **Software intensive systems encourage*:**
  - Build-a-little, test-a-little, field-a-little risk reduction
  - Incremental and spiral development efforts
  - Concurrent planning, development and sustainment activities
- **No longer a natural 'break point' where software development can be transitioned to a sustainment organization**
  - Technical capability of Government sustainment organizations reduced due to acquisition reform
- **Planning for software sustainment now a lost art**
  - Acquisition programs no longer produce MIL-HDBK-347 Computer Resource Life Cycle Management Plans

Better planning needed to partition software work among multiple developers and increase competition

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*AIAA Infotech Conference 2009, Software Sustainment Challenges in Defense Acquisition

NDIA Software Test and Evaluation Summit/Workshop – Sep 2009

- **Purpose: "Recommend policy and guidance changes to emphasize robust software T&E approaches in Defense acquisition."**
- **Speakers from Government, Industry and Academia**
- **Conducted workshops on:**
  - How much software T&E is enough
  - Software T&E involvement across the lifecycle
  - Emerging paradigms: SOA, SoS, Security
- **Workshops specifically addressed:**
  - Policy & guidance, Human capital, RFP language, SW T&E tools
- **NDIA Software Experts and DT&E sub-committee to produce white paper by December 2009**

Software Measurement and Analysis Improvement Areas

Determine better methods of obtaining cost estimating data	Generate software appropriate WBS	Find best Earned Value Management (EVM) practices for SW
	Improve estimation tools, techniques, & practices	Link quality indicators to EVM

Concepts - Requirements - Arch/Design - Development - Maintenance

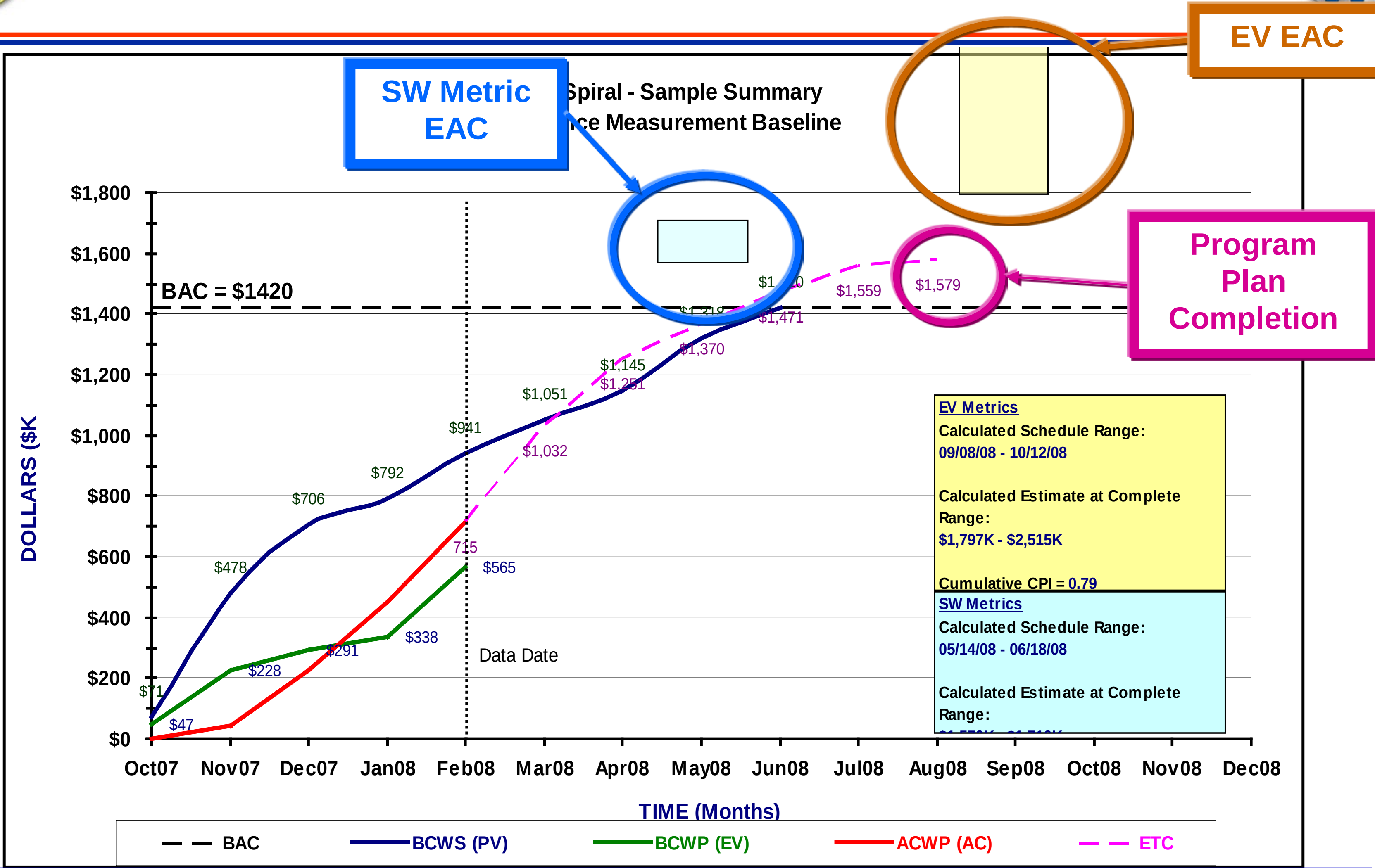
Integrate software guidance into proven management techniques

Software Earned Value Management (EVM) Study/Pilot

- **Develop methods to combine EVM and software metrics to predict cost and schedule overruns**
- **Piloted on a 5-year ACAT 1D software development program**
- **Pilot indicator shows estimate-at-completion (EAC) forecasts for:**
  - Existing program management plans
  - Milestone-based EVM measures
  - Software metrics, i.e, growth profile of size, effort, defects

Equivalent EAC forecasts provide an increased confidence in project plans

Estimates at Completion (EAC) for Metrics, Earned Value, Program Plans



Confidence increases as EACs overlap

Multiple measures reaching the same conclusion

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Questions/Discussion

<u>Contact Information:</u>

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Deputy Director, Software Engineering

Systems Engineering Directorate, Defense Research and Engineering

Scott.Lucero@osd.mil

Raytheon
Customer Success Is Our Mission

Using Model-driven Engineering Techniques for Integrated Flight Simulation Development

Douglas Fiehler
Brett Collins
Jesse Carlaftes
Raytheon Missile Systems
October 29, 2009

Outline

- Introduction of Model-driven Engineering (MDE)
- History of MDE at Raytheon Missile Systems
- Intentions of Using MDE for Integrated Flight Simulation (IFS) Development
- MDE Tool History Example
- Model Lifecycle Comparison
- MDE Process Flow
- Time Savings Comparison
- Performance in Integrated Flight Simulations
- Common Pitfalls
- Conclusions

Introduction of Model-driven Engineering

Raytheon Missile Systems

- Model-driven Engineering
  - A.K.A. Model-driven Development (MDD)
  - Software development methodology that focuses on creating models rather than algorithms
  - Domain experts maintain more control of the software end product
  - Promotes compatibility and communication between individuals/teams
- One Tool's Role in MDE
  - Simulink® is a Popular tool for domain experts' development of system models
  - Real-Time Workshop® Embedded Coder provides MDE interface to Integrated Flight Simulations (IFSs) through automatic generation of C/C++ code
  - IFS engineer owns process of creating code

Real-Time Workshop® provides an MDE interface to the IFS

History of MDE at Raytheon Missile Systems

Raytheon
Missile Systems

- Initial work
  - Automatic code generation process created to support rapid algorithm development
    - Identified limitations and pitfalls
    - Standardized deployment for incorporation in object oriented simulations
  - Original Processes developed using release Matlab® R11
- Ongoing efforts
  - Process has been implemented on many programs
    - Hardware models
    - Control algorithms
    - Medium and high fidelity
  - Presently using Matlab® Release 2009a
    - Processes updated for current releases

MDE Processes are in place and are being used at Raytheon Missile Systems.

Intentions of Using MDE for Integrated Flight Simulation Development

- MDE is a powerful process for designing models, both hardware and software, for simulations
  – Because of requirements imposed on IFSs, impractical to develop entire simulation with MDE
- Early development of IFSs requires frequent changes to models
  – Automatic code generation from MDE methods saves time, not only in initial integration of the model into the IFS, but subsequent changes can be made simpler and quicker.
- While much initial model design work done with Simulink®, other MDE tools are used to develop flight software

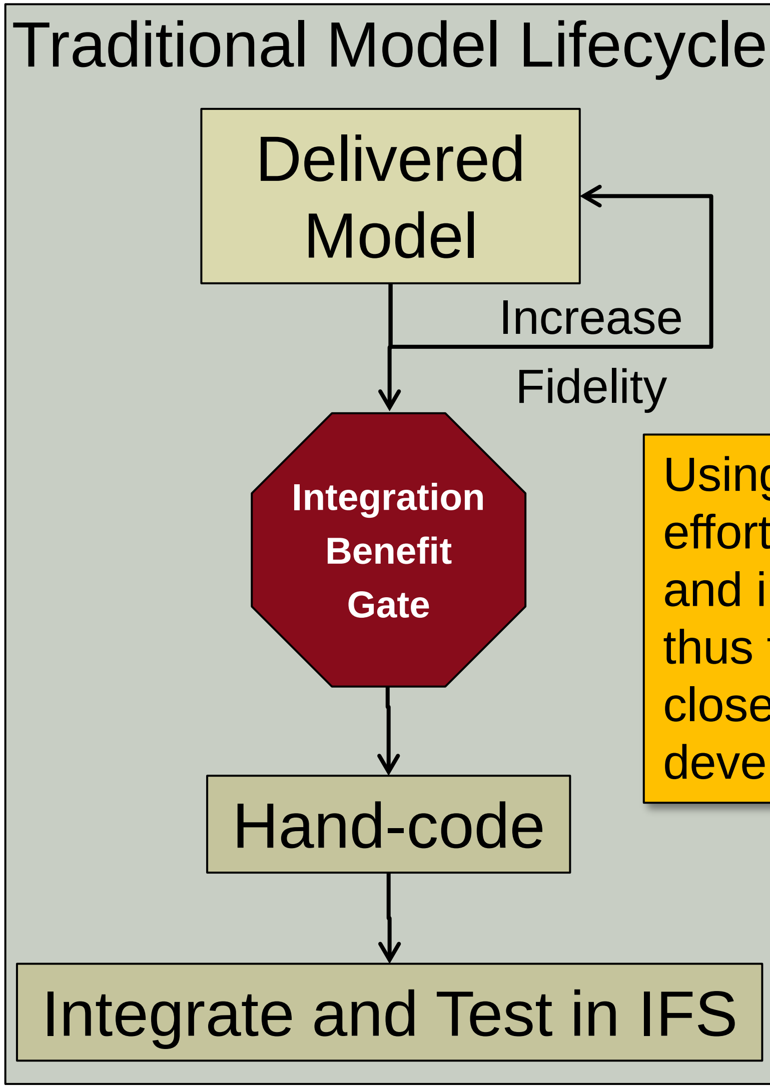
MDE, when used appropriately, is a powerful tool for IFS development

MDE Tool History Example

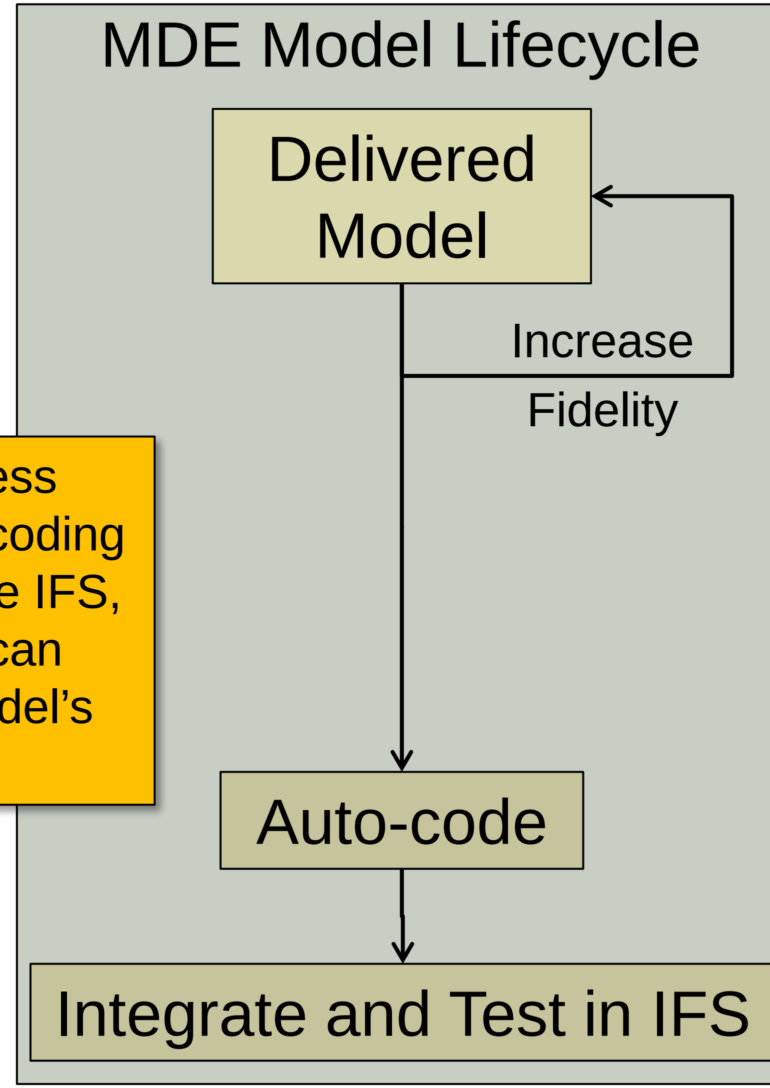
- MDE Tools Evolve Over Time, and so must MDE processes
  - Matlab® R2008a and Previous
    - Would generate only C code
    - C++ option only changed the file extensions from ".c" to ".cpp"
    - Early versions (R11) could only support discrete models
  - Releases Since Matlab® R2008b
    - Includes option to generate "Encapsulated C++" code
    - True C++ class that can be instantiated in the IFS (multiple times if needed)
    - Includes Initialize, Step, and Finalize member functions
    - Additional member functions for setting or getting static input variables

Continuous MDE tool improvements require process improvements

Model Lifecycle Comparison

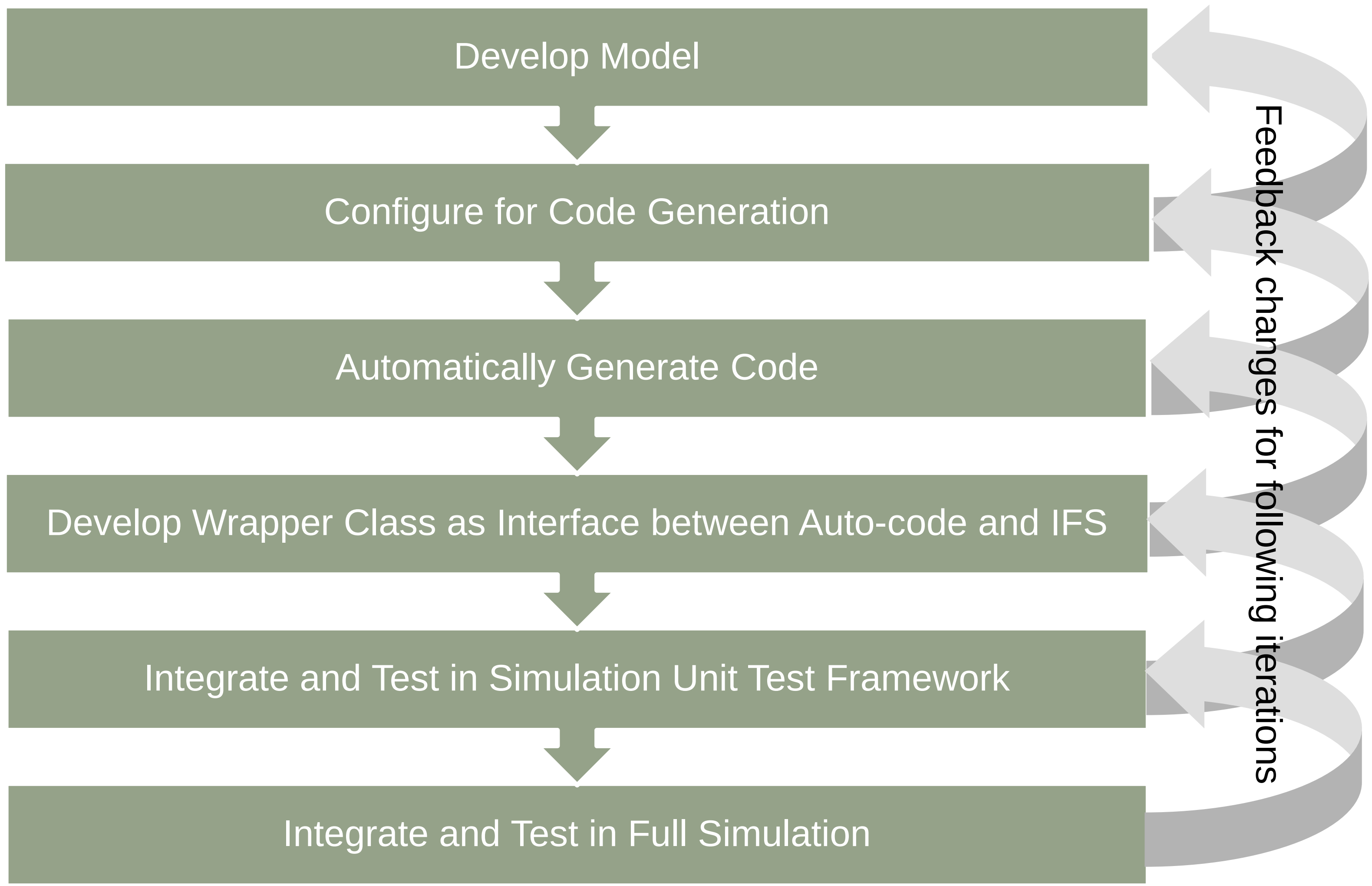


Using MDE, much less effort is needed for coding and integration in the IFS, thus the simulation can closely track the model's development cycle.



Autocoding can reduce cycle time for integrating updated models

MDE Process Flow



Straightforward process using MDE models to develop Functional Simulations

Time Savings Comparison

- Hardware model coded
  - Control Actuation System model
  - Representative model for most hardware models integrated in IFS
- Used three methods to obtain time comparisons
  - Hand-coded from Simulink® block diagram
  - Auto-coded using original process using Matlab® R11
    - Can only use discrete blocks and integration when auto-coding
  - Auto-coded using updated process using Matlab® R2008b
    - Continuous blocks and integration supported
- Note that process times are for a first pass through the auto-coding process
  - Subsequent integrations of the same model should show even further process time reductions

Time Savings Comparison

Task	Hand-coding (hr)	Auto-code without Continuous Block Support (hr)	Auto-code with Continuous Block Support (hr)
Create usable source code from using MDE			
Insert and connect generic I/O port content		2	2
Replace Integrators with ports		2	
Continuous block identification and replacement		8	
Auto-code option selection and code generation		<1	<1
Preparation of generated code		4	4
Handcoding model - Simulation	60		
Handcoding model – Algorithm Design Tools	60		
Subtotal	**120**	**17**	**7**
Common efforts to integrate code into IFS			
Modifying IFS wrapper object, input files, etc	4	4	4
Performing unit Tests for verification	4	4	4
Performing Simulation Tests for verification	10	10	10
Subtotal	**18**	**18**	**18**
Total Conversion Time	**138**	**35**	**25**
% of Hand-coding	**100%**	**25.4%**	**18.1%**

Significant time savings when auto-coding models

Performance in Integrated Flight Simulations

Raytheon Missile Systems

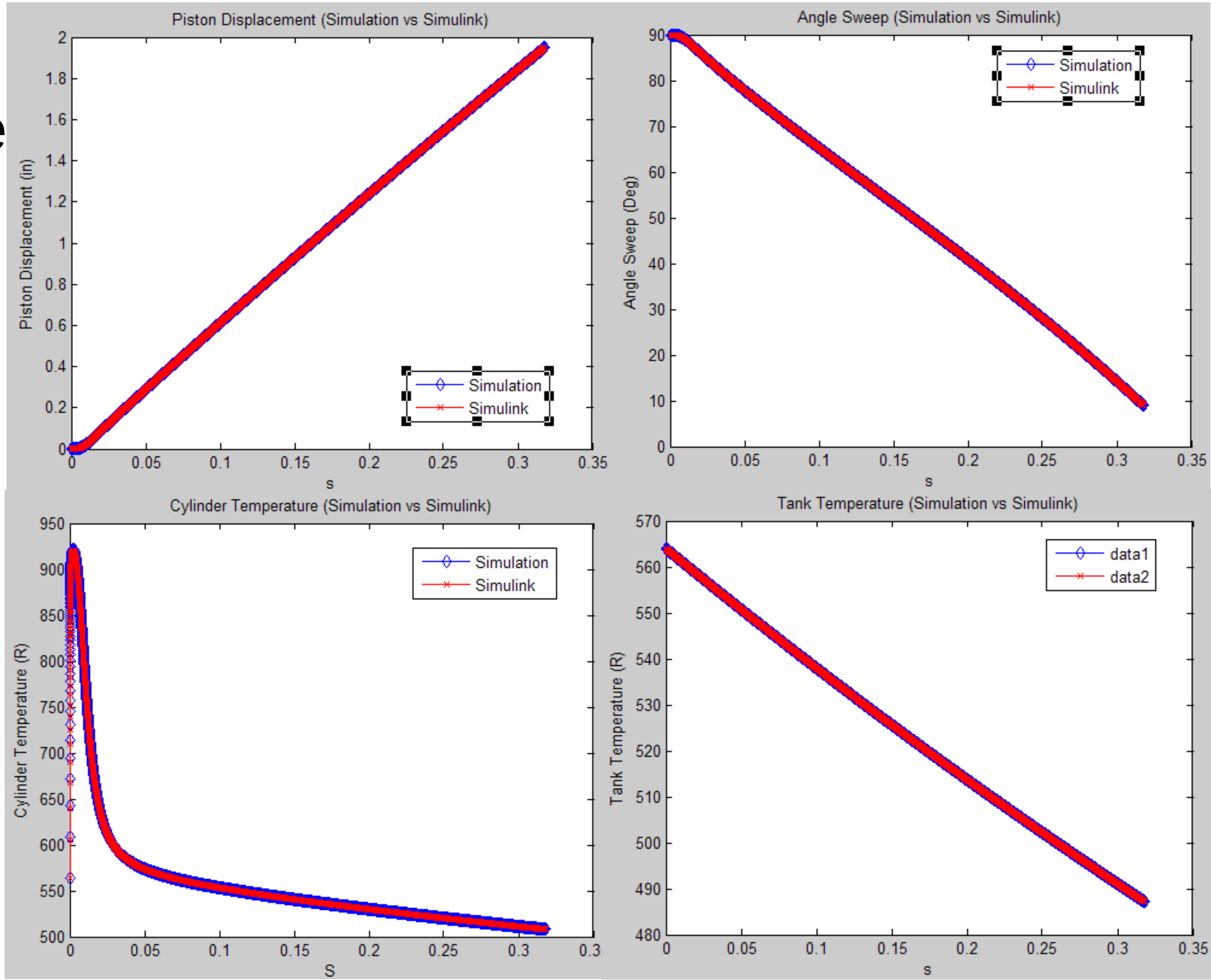
- Currently using MDE processes in simulations on multiple programs
- Extensive verification of models performed
  - Developed detailed processes for conversion of the model to C/C++ code
  - Verified performance of the models integrated in the IFS match the performance of the original model as a unit test
  - Regression runs of the full simulation completed to verify performance of the model in the IFS
- Processes updated and tested with latest tool capabilities

Methodical and Thorough Process Used in Development of IFSs using MDE Methods

Performance in Integrated Flight Simulations

Raytheon
Missile Systems

- Wing Actuation System Hardware Model

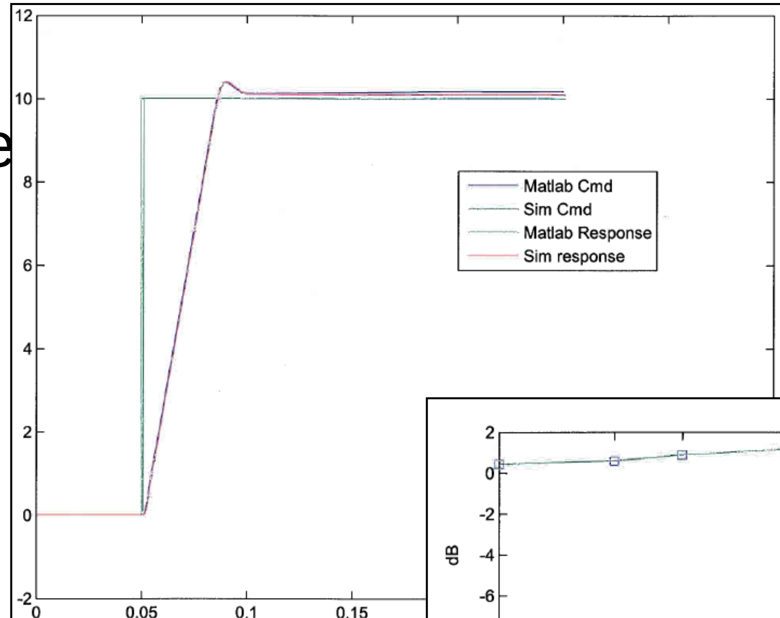


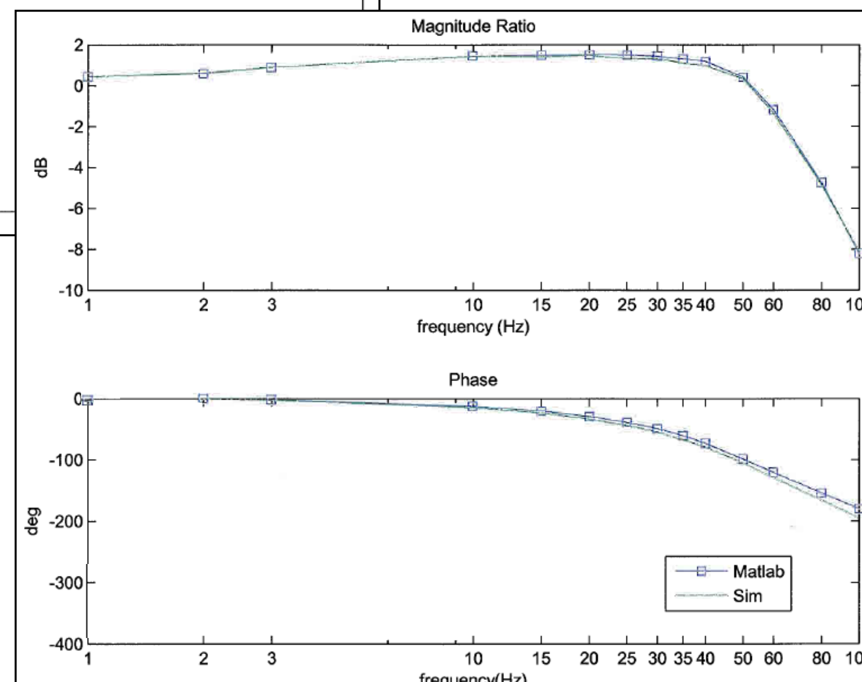
Good Agreement in Time Domain Performance

Performance in Integrated Flight Simulations

Raytheon Missile Systems

- Control Actuation System Hardware Model
  – Step response
  – Bode Plot





Good Agreement in both Time and Frequency Domains

Common Pitfalls

Raytheon Missile Systems

- Model Configuration
  - Every model is different, new configurations produce new problems
  - Common model design standards needed for developers to streamline integration into the simulation
- Tool Capabilities
  - As with any tool, user must understand process, model, and MDE tool, not a “push-button” process
  - Common areas to watch
    - Timing – no time shift present
    - Does auto-code accurately represent the system? Auto-code should identically reproduce outputs given identical inputs
- Integration Schemes
  - Internal
    - Continuous – Only available in later releases of Matlab®
    - Discrete – Not always the choice of model developers for representing system
  - External
    - Tie into simulation numerical integration schemes
    - Reduces ability to verify against original model

While MDE tools are useful, care must be taken in model development

Conclusions

- Raytheon Missile Systems has successfully used MDE processes to incorporate models into IFSs
- Full set of procedures developed to aid personnel cross-program and to train new users
- Procedures verified with multiple models on multiple simulations
- Procedures are updated as new features become available in MDE tools
- Generating code automatically using MDE processes can save significant amounts of time preparing models for incorporation in simulations, and can be completed with confidence

Engineering Improvement in Software Assurance: A Landscape Framework

Lisa Brownsword (presenter)
Carol C. Woody, PhD
Christopher J. Alberts
Andrew P. Moore

Agenda

Assurance Terminology

Problem Scope

Modeling Framework Overview

Selected Elements of the Framework Pilot

Summary and Next Steps

Assurance

System assurance

- The justified confidence that a system functions as intended and is free of exploitable vulnerabilities, either intentionally or unintentionally designed or inserted as part of the system at any time during the life cycle*

Software assurance

- Software's contribution to system and system of systems (SoS) assurance
  - Software assurance in the context of a system's and SoS mission and use

Justified confidence: rational basis for deciding about SoS readiness for use

Functions as intended: involves user expectations, which change over time

Environment of use

- Actual environment of use (not just the expected environment of use)
- Means evaluating robustness against *unexpected* use, threats, and changes in the environment

* Engineering for System Assurance, NDIA System Assurance Committee, 2008, www.acq.osd.mil/sse/pg/guidance.html

Problem Scope

Numerous assurance solutions (i.e., technologies, policies, and practices) are available

- A large number of organizations produce, fund, or use these assurance solutions
- How these assurance solutions contribute to operational assurance is often unclear

Operational environments are plagued with undiscovered defects and escalating numbers of known vulnerabilities

- Where should resources be invested to gain the most benefit?
- Where are the critical gaps in available assurance solutions?
- What additional assurance solutions are needed?
- Are the incentives for routinely applying assurance solutions effective?

A Solution Approach

Goal – longer-term

- Identify gaps, barriers, and incentives to the formation, adoption, and application of assurance solutions (i.e., technologies, policies, practices) to improve operational assurance
- Exploit this knowledge to accelerate the formation, adoption, and application of appropriate assurance solutions

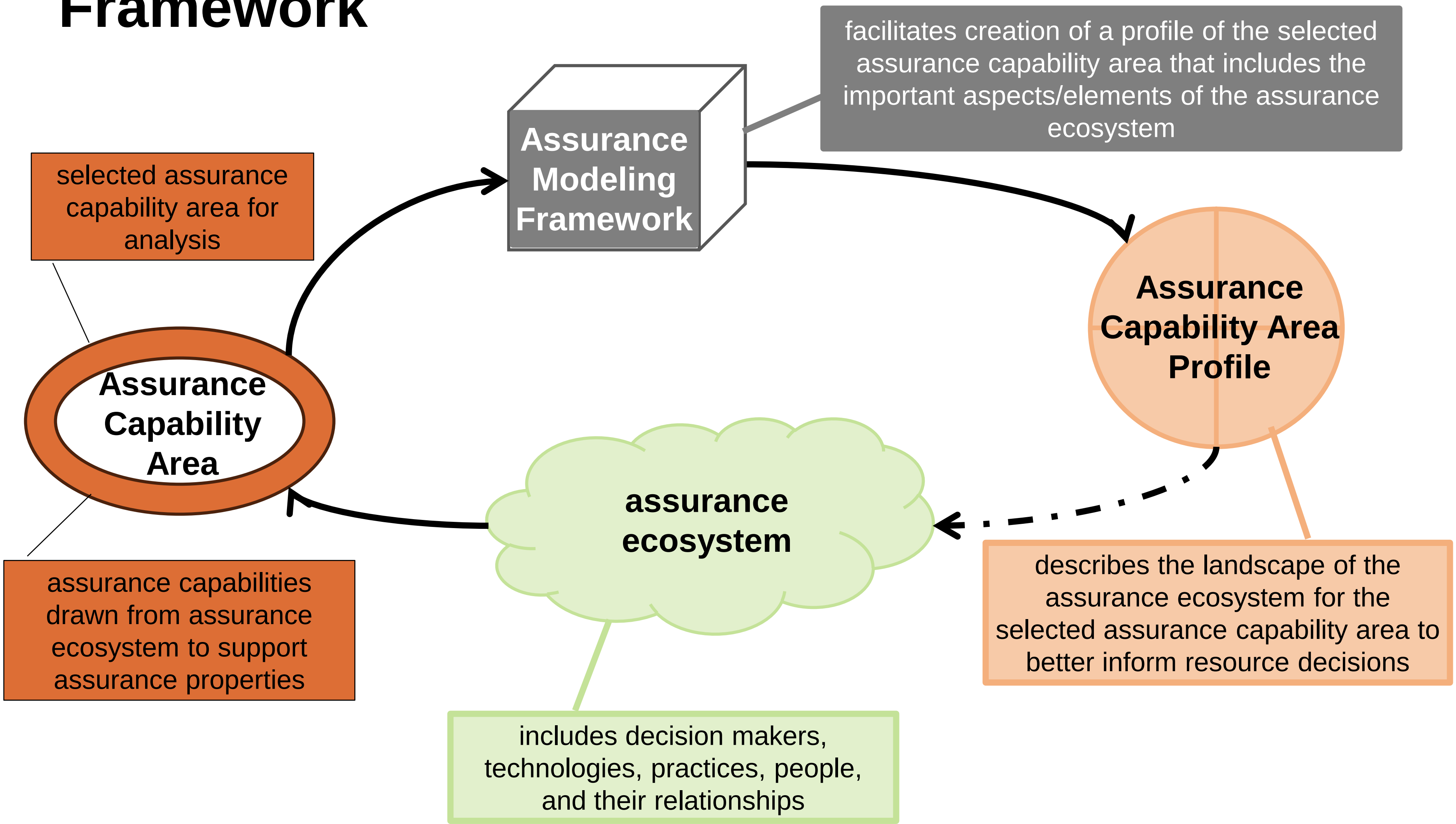
Near-term approach

- Build a modeling framework that
  - Characterizes the current portfolio of organizations working in assurance, available assurance solutions, and how they work together to improve operational assurance
  - Characterizes the gaps, barriers, and incentives related to the adoption and application in operational environments of assurance solutions
- Leverage (or adapt) existing modeling and analysis methods

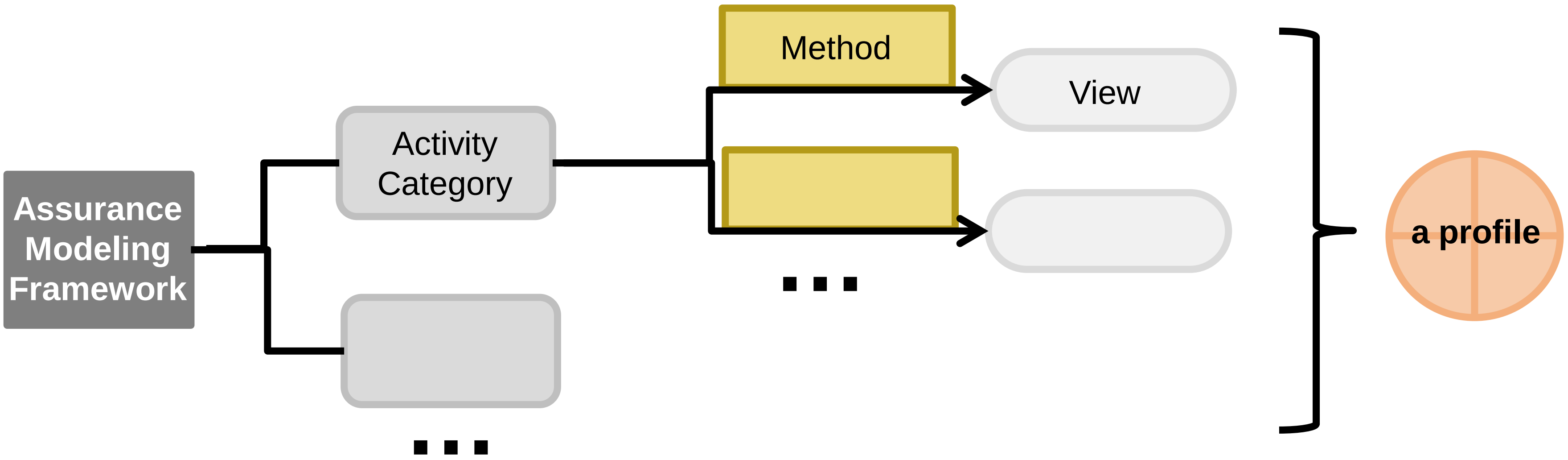
Where might we start?

	Key Information for a Modeling Framework to Address
1	How is software assurance value defined for a selected context?
2	Who/what are the participating organizations and assurance solutions?
3	What are the elements of value exchanged among participants?
4	How do participating organizations and assurance solutions work together to achieve operational assurance?
5	What are the drivers and motivations of participating organizations?
6	What are the critical usage scenarios and behaviors among the participating organizations and assurance solutions?
7	What are the adoption and operational usage mechanisms used for assurance solutions?
8	How are the adoption and operational usage mechanisms aligned with organizational context and need?
9	What is the impact of future trends and events on participating organizations and assurance solutions?
10	What patterns of possible inefficiencies can be identified?
11	What are candidates for improvements? What could be the impact, if implemented?

Conceptual Context of Assurance Modeling Framework



Structure of Assurance Modeling Framework

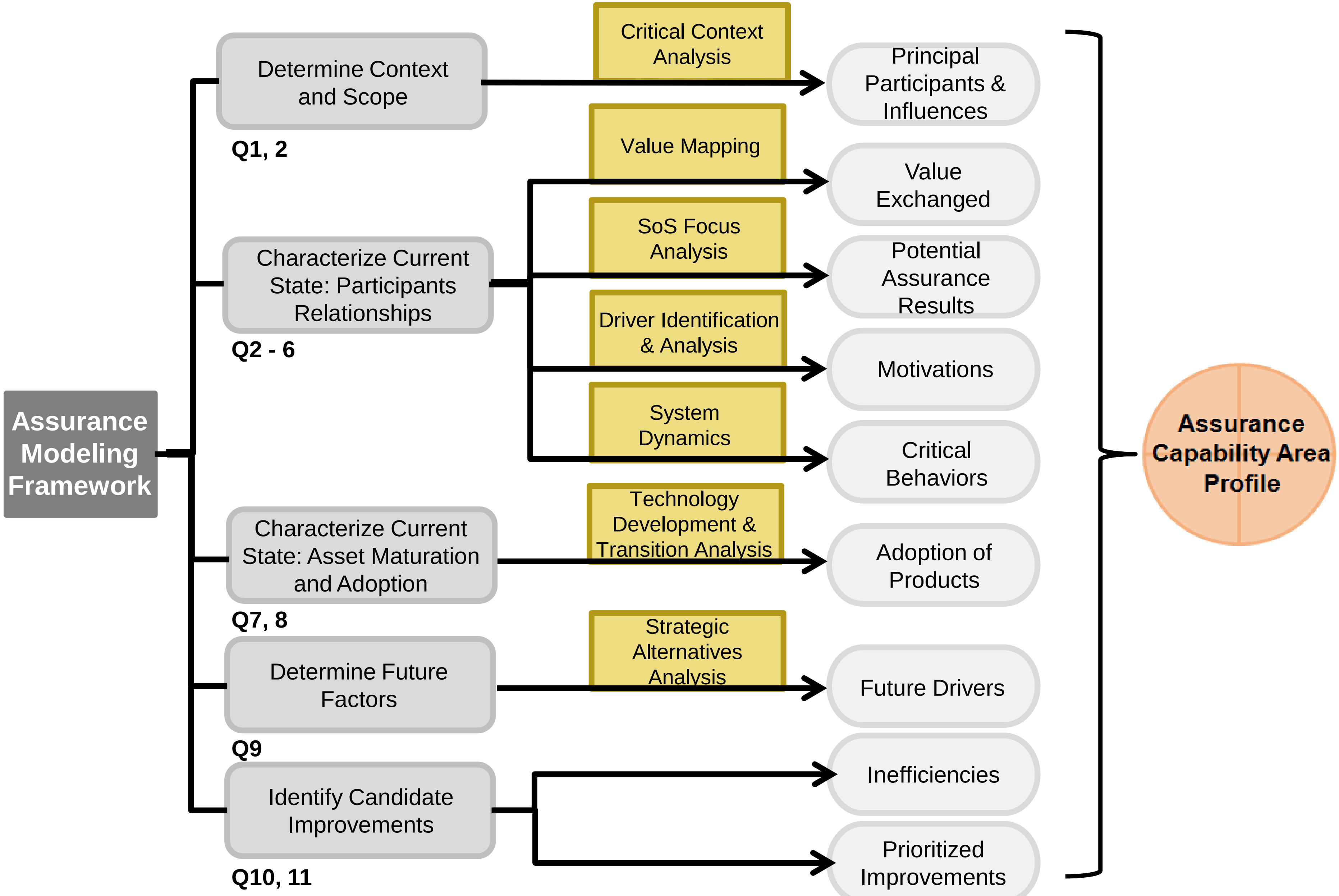


Our modeling framework is comprised of multiple *categories of activities* necessary to produce an assurance capability area profile

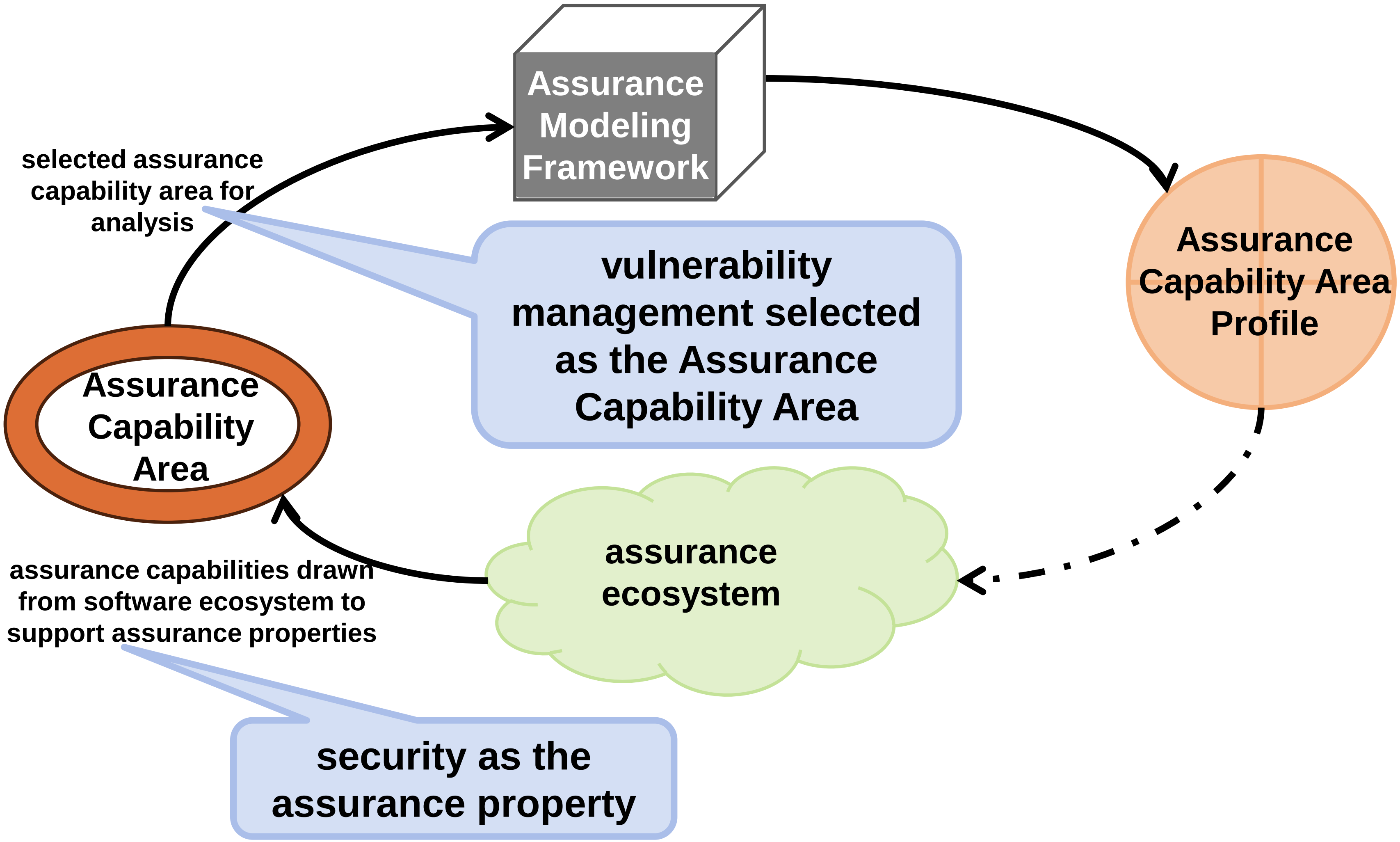
Each activity category focuses on developing insights on one or more of the framework information questions and produces one or more *views*

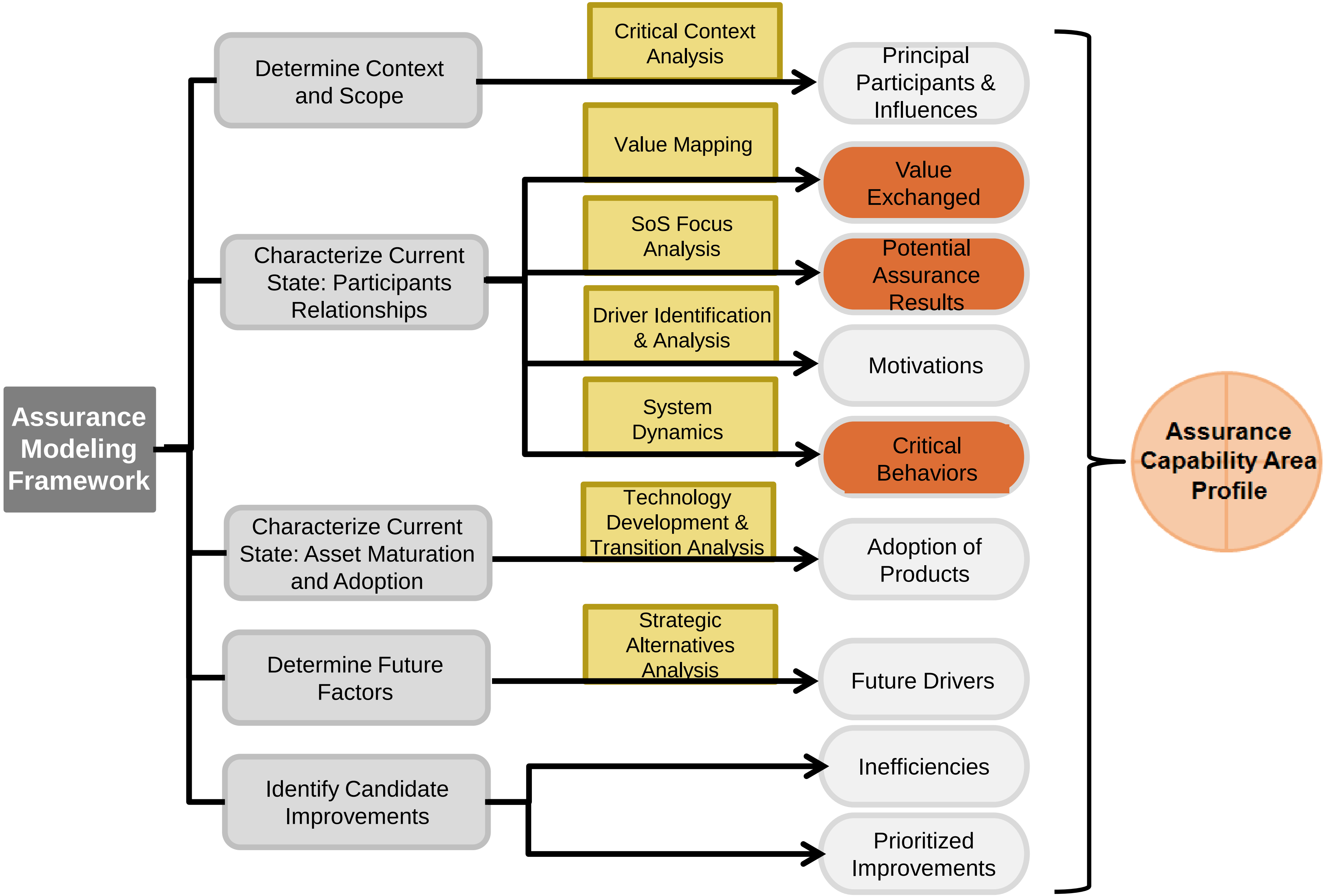
Each view is formed using one or more *methods*

A *profile* is a set of views that collectively describe an assurance landscape


Assurance Modeling Framework
Determine Context and Scope
Q1, 2
Characterize Current State: Participants Relationships
Q2 - 6
Characterize Current State: Asset Maturation and Adoption
Q7, 8
Determine Future Factors
Q9
Identify Candidate Improvements
Q10, 11
Critical Context Analysis
Value Mapping
SoS Focus Analysis
Driver Identification & Analysis
System Dynamics
Technology Development & Transition Analysis
Strategic Alternatives Analysis
Principal Participants & Influences
Value Exchanged
Potential Assurance Results
Motivations
Critical Behaviors
Adoption of Products
Future Drivers
Inefficiencies
Prioritized Improvements
Assurance Capability Area Profile

Pilot Use of the Assurance Modeling Framework

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Principal Participants & Influences
Value Exchanged
Potential Assurance Results
Motivations
Critical Behaviors
Adoption of Products
Future Drivers
Inefficiencies
Prioritized Improvements
Assurance Capability Area Profile

View: Value Exchanged (Q2, 3, 4)

Method: Value Mapping

- Shows static relationships among principal participants (organizations and assurance solutions)
- Shows primary elements of value exchanged between two participants

Selected insights

- One organization or technology by itself does not mean a great deal; its relationship to other organizations and technologies has meaning
  - An organization may play several roles in the assurance ecosystem
- Values identified in value exchanges may have only an indirect effect on operational assurance and is often difficult to determine
- The models provide an effective way for assurance solution owners to describe and better understand the key relationships associated with their solution

Sample CVE Value Map -1

Legend

Symbols

Participant	A participant (e.g., organization or technology) in a value exchange
●	Data source for public information with multiple contributors

Line Style

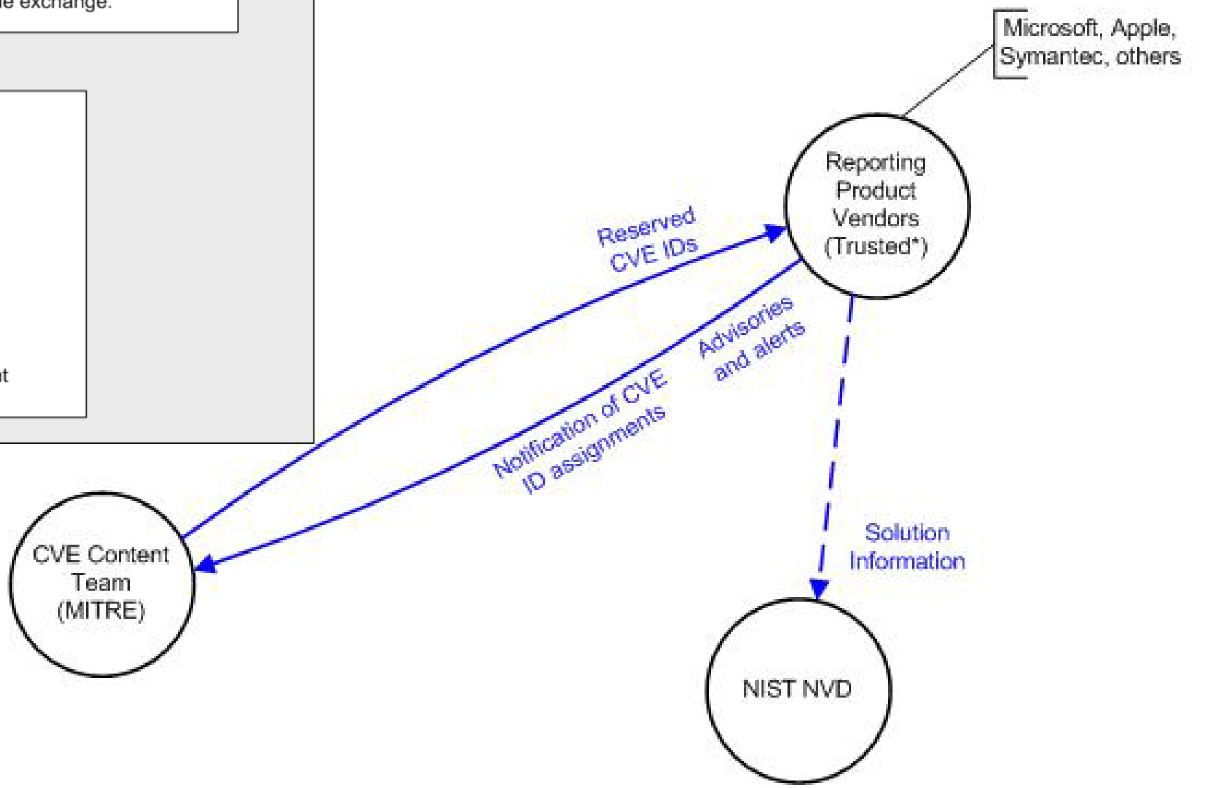
Dashed arrow	Value is pulled by destination organization.
Solid arrow	Value is pushed from source organization.

Note: The direction of the arrow shows the flow of the value exchange.

Line Colors

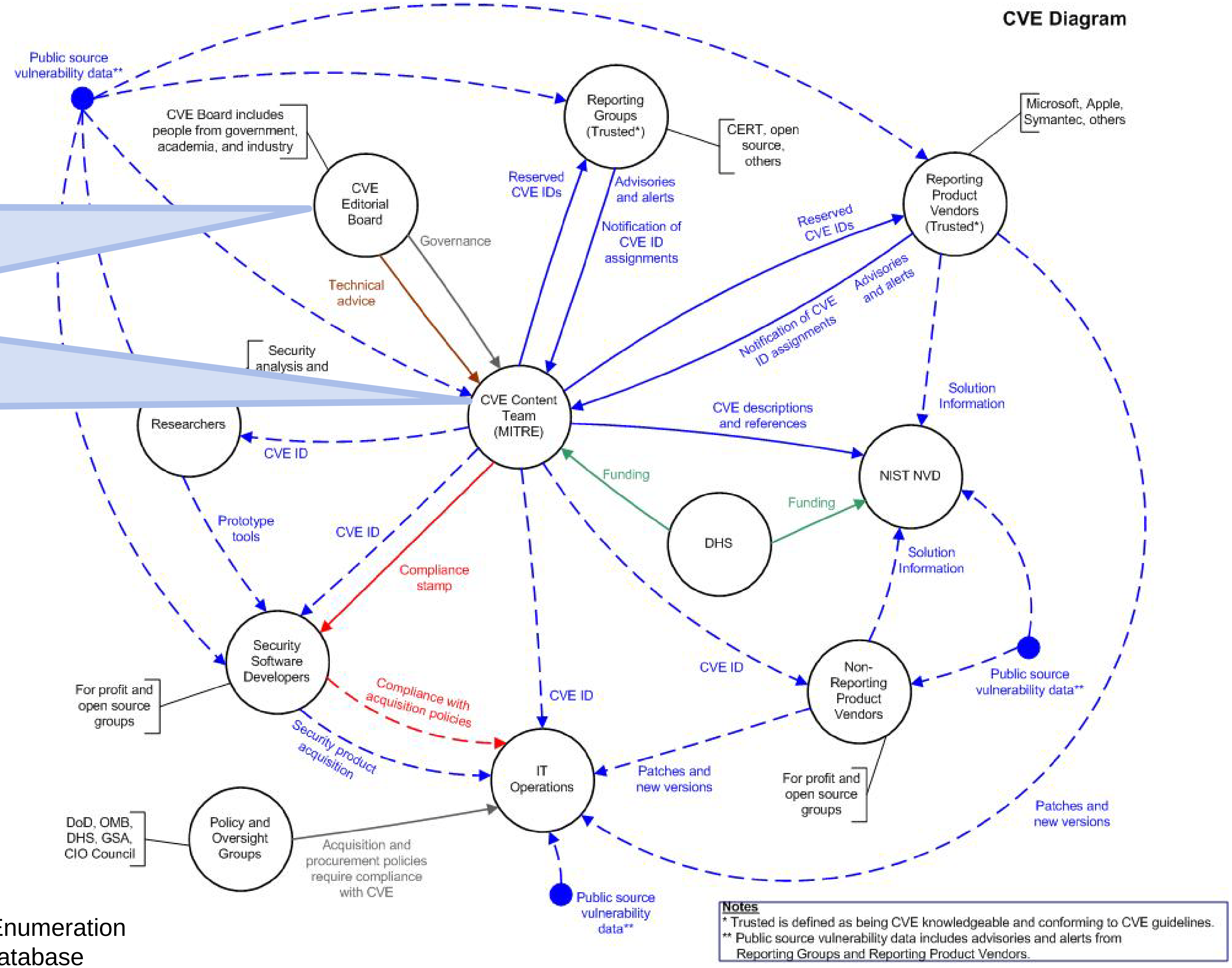
Green	Funding
Blue	Product
Brown	Service
Gray	Governance
Red	Compliance
Orange	Endorsement

Partial CVE Diagram – Notation Example



Sample CVE Value Map -2

An organization may play multiple roles with different values exchanged



CVE – Common Vulnerability Enumeration
NVD – National Vulnerability Database

View: Potential Assurance Results (Q2, 4)

Method: SoS Focus Analysis

- Produces a model for alignment of services between suppliers of assurance solutions to what operational users do to achieve operational assurance
- Oriented to defining collaborations within complex, socio-technical systems (of systems) domains

Selected insights

- The effect an assurance solution has on achieving operational assurance is often not direct
  - It is a network of relationships among organizations and assurance solutions that must be understood within their operational context
- The models surface potential areas of inefficiencies for further analysis

SoS Focus Analysis with CVE

Potential inefficiencies:
- where tacit knowledge is held
- where people manually synthesize significant information from multiple sources

What Vendors	How CVE, NVD		Who Security analysts	Who Computer installations & operations	Why User environments
Addressing known vulnerabilities	*Disseminating vulnerabilities and patches*	*Maintaining current knowledge of vulnerabilities and patches*	*Maintaining current knowledge of available patches & site configurations; forming site solutions*	*Maintaining awareness of risks and effectiveness of solutions*	*Operational assurance in the context of use*
Building, testing, issuing patches	Registering	Monitoring	Tracking, analyzing, forming solutions	Installing solutions, monitoring effectiveness	Operational availability and integrity
Supply-Side			**Demand-Side**		
1	2	3	4	5	6

View: Critical Behaviors (Q6)

Method: System Dynamics

- Produces a model for analyzing critical behaviors within complex socio-technical system of system domains
- Identifies primary positive and negative feedback loops driving critical behaviors

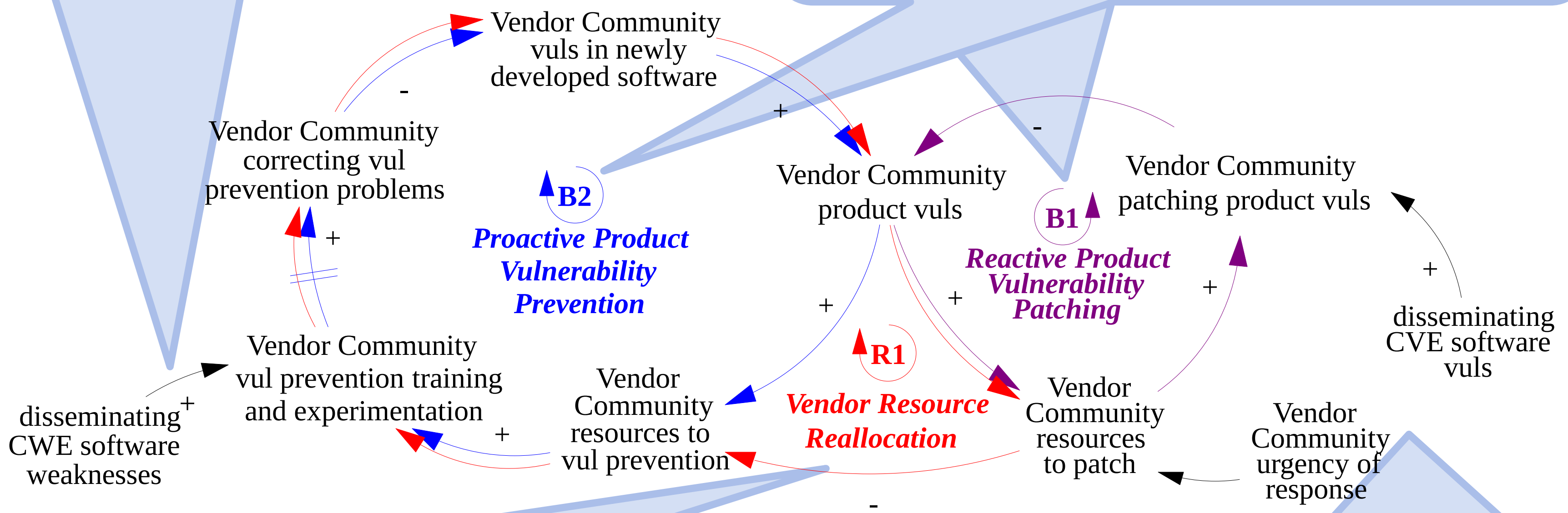
Selected insights

- There is a tension in the vendor community between resources for proactive software vulnerability prevention practices and reactive patch generation and release practices
  - Urgency of response has historically promoted reactive practices
  - CVE-induced market pressures are beginning to promote proactive practices
- The models provide a structured way to approach discussions among technology representatives and other affected stakeholders

Sample System Dynamics Model

3. The proactive approach focuses on a strategy of vulnerability prevention based on applying CWE information within the vendor community to developed software that prevents vulnerabilities.

1. Vendors must decide how to split resources between reactive and proactive responses to product vulnerabilities to balance the need for an immediate response with the need for a proactive solution that prevents product vulnerabilities.



4. If vendors feel the need to devote more resources to vulnerability patching and less to vulnerability prevention, then this leads to a downward spiral of increasingly vulnerable products and ever increasing assurance problems.

2. The reactive approach patches product vulnerabilities based on CVE information. The development of patches is prioritized based, in part, on the impact a given vulnerability is having on the operational community.

Summary

Assurance modeling framework lays important groundwork by providing a multi-dimensional approach to

- Better understand relationships between organizations and assurance solutions and how these relationships contribute to operational assurance
- Begin identifying potential areas of inefficiencies across a spectrum of technical and organizational areas

Status of SoS software assurance modeling framework project

- Completed initial version of the assurance modeling framework and validated it through the pilot on vulnerability management as a selected assurance capability area
- Finishing up a report on the modeling framework and its pilot use

Next Steps

- Expand modeling of future trends and technology formation and adoption
- Review the behavioral system dynamics models with community representatives
- Review usage scenarios of the pilot profile with community representatives
- Expand the use of the framework to another aspect of software assurance

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Evolving Systems Engineering through Model Driven Functional Analysis

Date: October 2009

Mark R. Blackburn, Ph.D., Fellow, Systems and Software Consortium (SSCI)

Sharad Kumar, Sr. Director Systems Engineering
General Dynamics Land Systems (GDLS)

Agenda

- **Functional analysis gap assessment**
  - Who we are
  - What's the situation
  - What we did
  - What we found
- **Perspectives that might apply to your organization**
  - Perspectives on functional analysis
  - What are the impacts of Model Driven Engineering (MDE)
  - How are things evolving
  - Some common recommendations made to SSCI members

About the Consortium

Systems and Software Engineering Practices

Realizing value from process improvement
- Value-driven process improvement
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- CMM®, CMMI® appraisals

Life cycle strategies for complex systems
- Disciplined Agility
- Systematic reuse / Product lines

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- Requirements analysis & automated testing
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This Project: Problem Area Assessment

General Dynamics Overview

- **Corporate Overview**
  - 5th largest U.S. defense contractor and a leading manufacturer of business jets
  - 2008 Sales of $29.3 billion
  - Approximately 92,900 employees operating in: United States, Australia, Austria, Canada, Germany, Mexico, Spain, Switzerland and the United Kingdom
- **Business Units and Operating Groups**
  - Aerospace – 15,300 Employees
  - ***Combat Systems – 18,500 Employees***
  - Information Systems and Technology – 34,000 Employees
  - Marine Systems – 22,000 Employees

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Combat Systems Group

- **General Dynamics Land Systems (GDLS) – Ground and Amphibious Combat Vehicles**
  - Headquartered in Sterling Heights, Michigan
  - Operating sites in Alabama, California, Florida, Maryland, Michigan, Ohio, Pennsylvania, Virginia, Washington, Australia and Canada
  - International Programs in Afghanistan, Australia, Canada, Egypt, Germany, Iraq, Israel, Kuwait, Morocco, New Zealand, Qatar, Saudi Arabia and the United Kingdom
- **European Land Systems – Armored Vehicles, Weapons and Ammunition**
  - Headquartered in Vienna, Austria with operating sites in Germany, Spain, Switzerland
- **Ordnance and Tactical Systems – Ammunition**
  - Headquartered in St. Petersburg, Florida with operating sites in Alabama, California, Florida, Illinois, Pennsylvania, Texas, Washington and Canada
- **Armament and Technical Products – Guns, Detection Systems and Composites**
  - Headquartered in Charlotte, North Carolina with operating sites in Arkansas, Maine, Mississippi, Nebraska, Virginia and Vermont

Medium Caliber Ammunition

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What's the Situation?

GDLS' processes and methods for functional analysis have the following objectives:

1. **Perform analysis in alignment with contract and industry standards**
2. **Reduce cycle time through continuous improvement**
3. **Maintain cycle time but increase value by greater through put, quality and consistency**
4. **Lead design by maturing interfaces, functional requirements and performance allocations into design cycle**

What We Did - Approach

- **GDLS requested that SSCI perform an assessment of their functional analysis practices**
  - SSCI worked with GDLS team to identify and scope the project – i.e. include anything related to functional analysis (e.g., processes, skills, technologies, organizational dynamics, etc.)
  - Conducted interviews/workshops with three lines of business that included domain experts, SMEs and a cross section of managers
  - Captured 110 individual items of feedback that SSCI reduced into about 20 general categories
  - Produced technical report summarizing the detailed findings
  - Conducted out-briefings to senior management on observations and recommendations

What We Found

- **Key Findings and Insights:**
  - Good processes, practices, and training have been developed and are in use by GDLS programs, but could be more tightly integrated
  - Modeling and simulation is being used to provide means for assessing performance and design alternatives to support system concept selection
  - Practices are evolving to leverage model-driven engineering
- **SSCI Recommendations**
  - Short-term and long-term recommendations addressing:
    - ***Integrated engineering***
    - ***Technology adoption***
    - ***Customer discussions on technology and process evolution***
    - Organization and responsibilities
    - Leveraging methods and domain knowledge expertise

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Perspective on Functional Analysis

- **First notable methods for functional analysis is often attributed to Lawrence D. Miles who was a design engineer for General Electric (1940s)**
  - Charles Bytheway extended Mile's functional analysis concepts and introduced the methodology called Function Analysis Systems Technique (FAST)
  - Key perspective came at functional analysis from a value perspective
  - Key focus is on alternative designs to achieve only the required functions at the lowest cost while meeting the fundamental requirements of the customer
- **As system complexity increases and where product lines are necessary, a broader view is needed**
  - Functional analysis provides inputs to architecting which are important for product lines

Conceptual Outputs of Systems Engineering Process*

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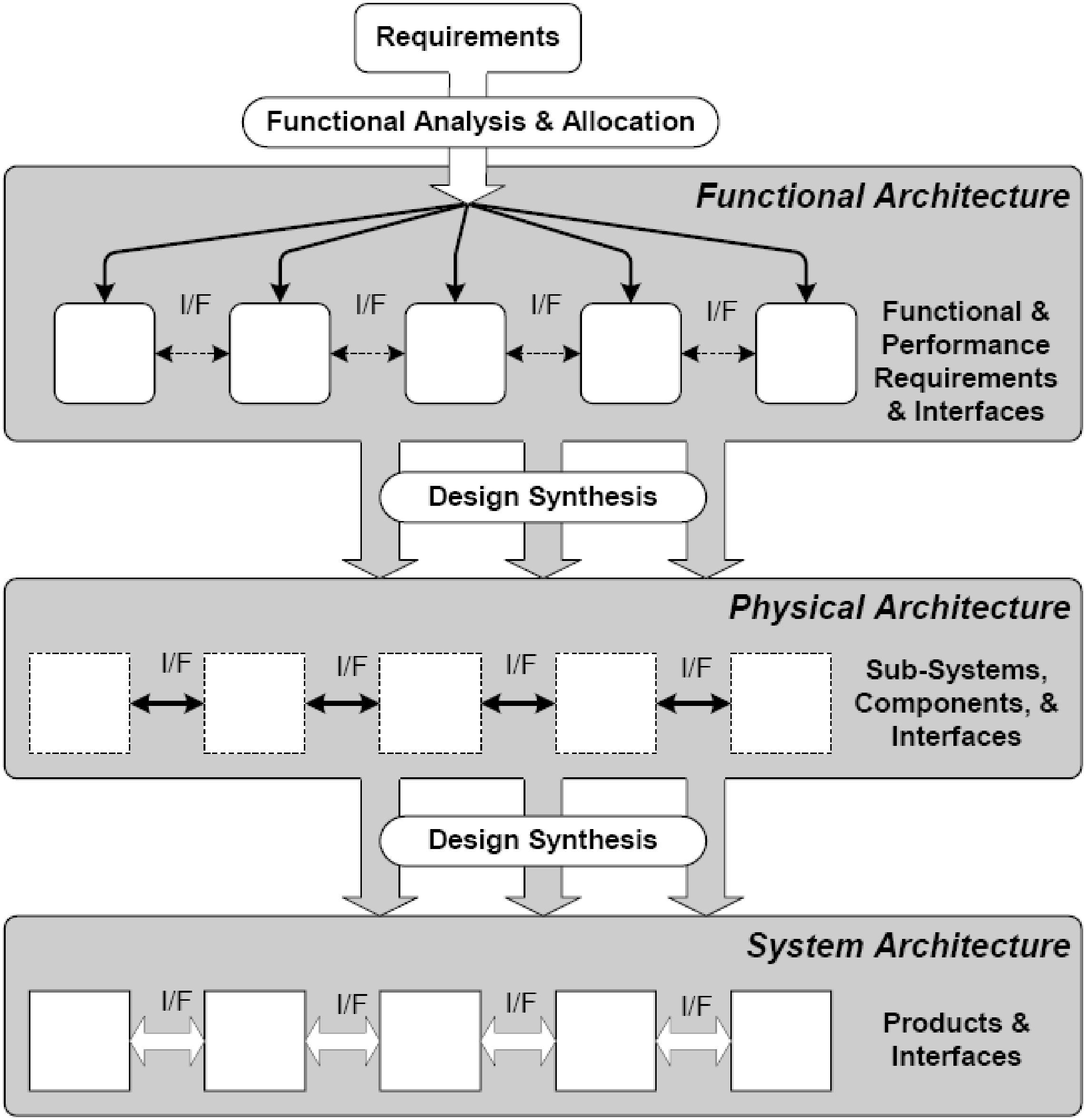
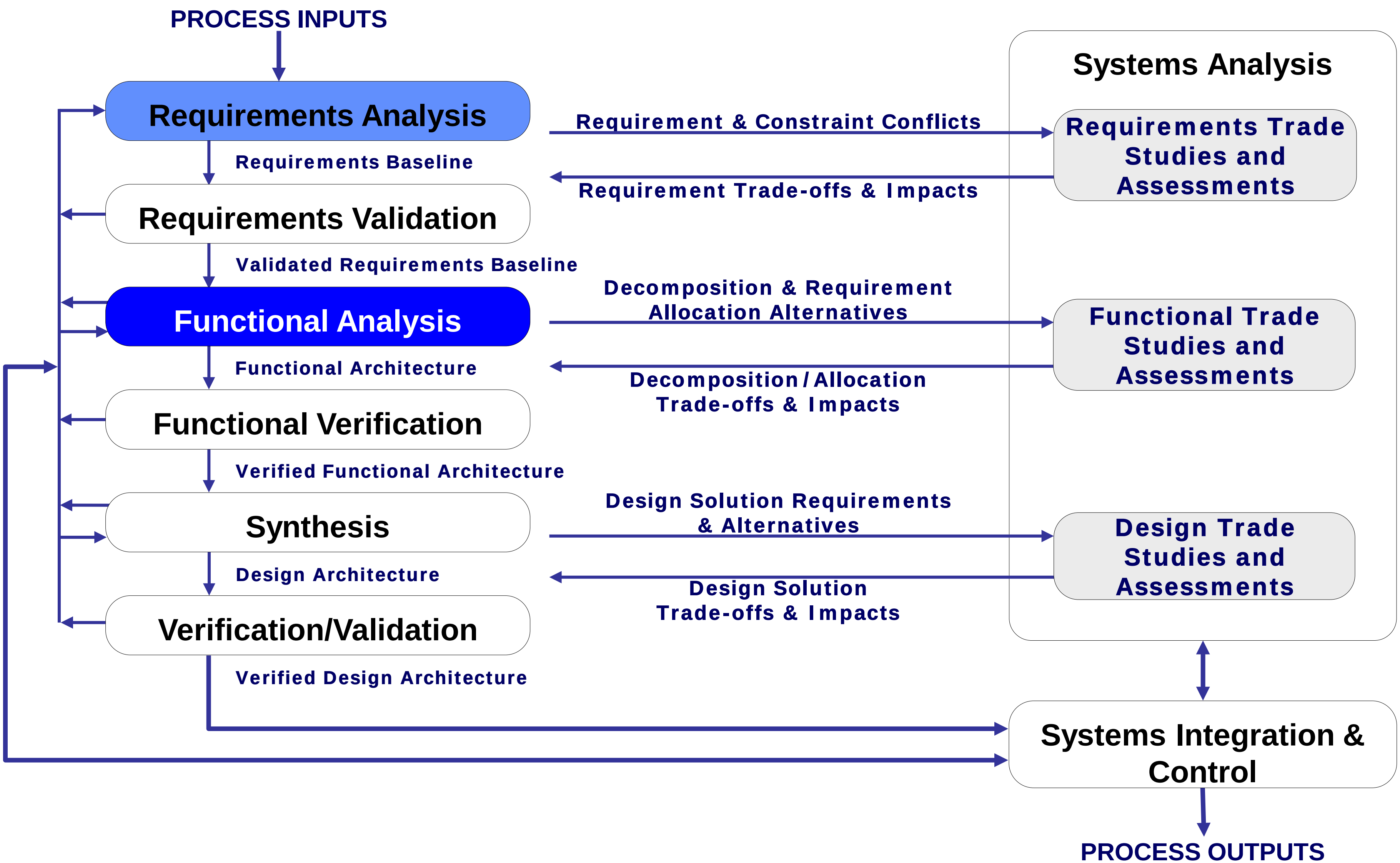


- **Fundamental information from functional analysis is:**
  - Derived requirements
  - Performance requirements
  - Interfaces
- **Documentation of alternatives and decisions**

Source: Condensed Guidelines for Successful Acquisition and Management of Software-Intensive Systems Handbook

GDLS Process Extends IEEE 1220 System Engineering Process

- **Represents the interfaces to Functional Analysis**



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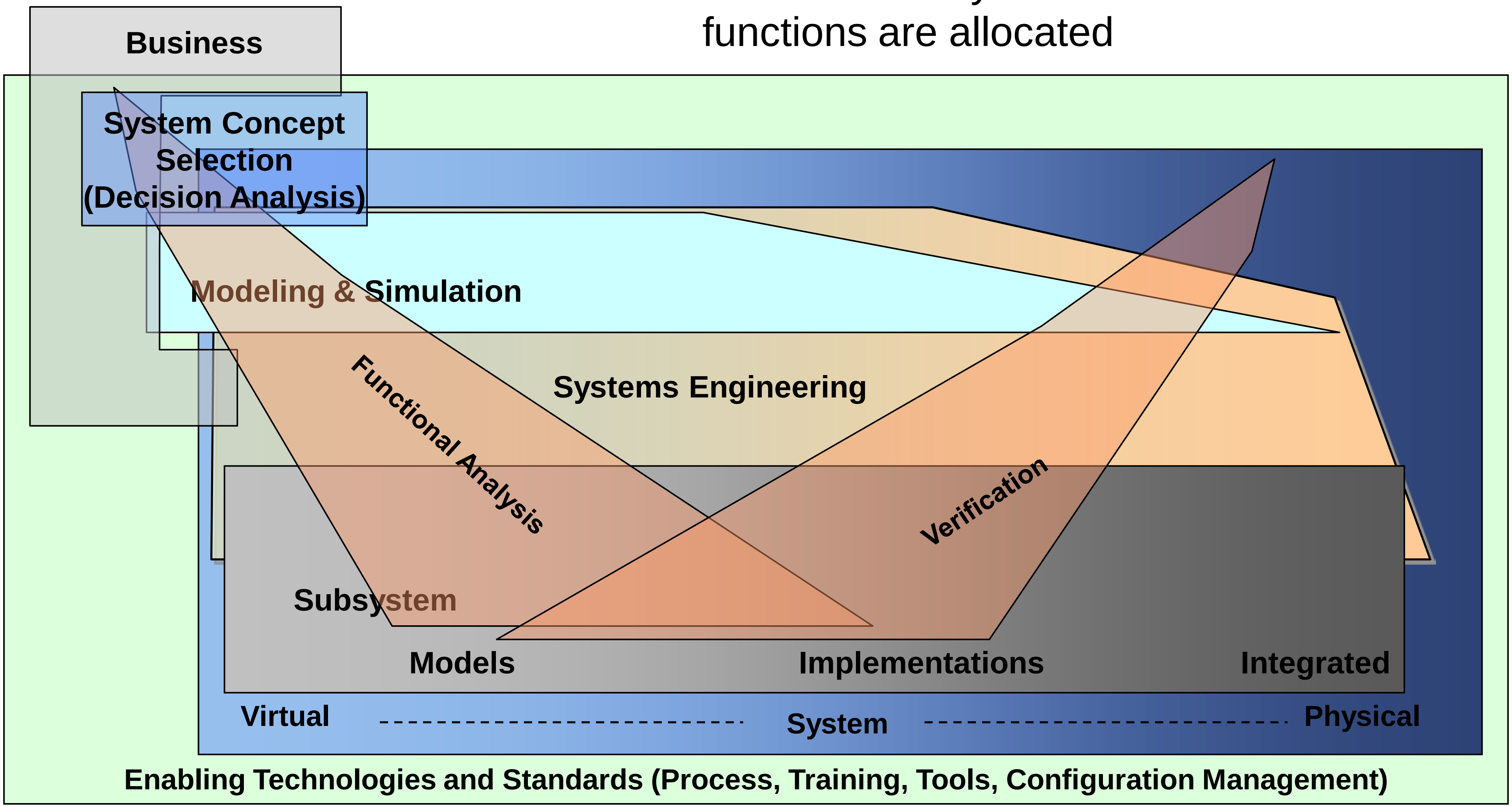
More of What We Found

- **GDLS is moving towards a broader view of functional analysis through the integration of:**
  - System concept selection supported by computational-based decision analysis for ranking alternatives
  - Modeling & simulation supporting performance, dynamic, structural, thermal, functional and combat analyses
  - System-level functional analysis that traces the potentially significant impact on lower-level decisions down through subsystems
  - Capture operational threads that cut across subsystems
- **Integrating functional analysis throughout system engineering and subsystems can be challenging**

Integrated Engineering

- **"Modern" perspective on functional analysis**

"Architect" needs to factor many alternatives into how functions are allocated



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Impacts of MDE Adoption

- **Driver: use UML-based notation to improve communication with software engineers**
- **Barrier: what UML-based notations for functional analysis are usable by system engineers and understandable by customers**
  - System Modeling Language (SysML) derived from UML for system engineers
  - UML and SysML are designed as a general-purpose language
  - Challenge becomes determining what modeling artifacts to use - how and when
- **Benefits of automation through tailored and integrated tooling**
- **Technology adoption readiness is a common issue with SSCI members**

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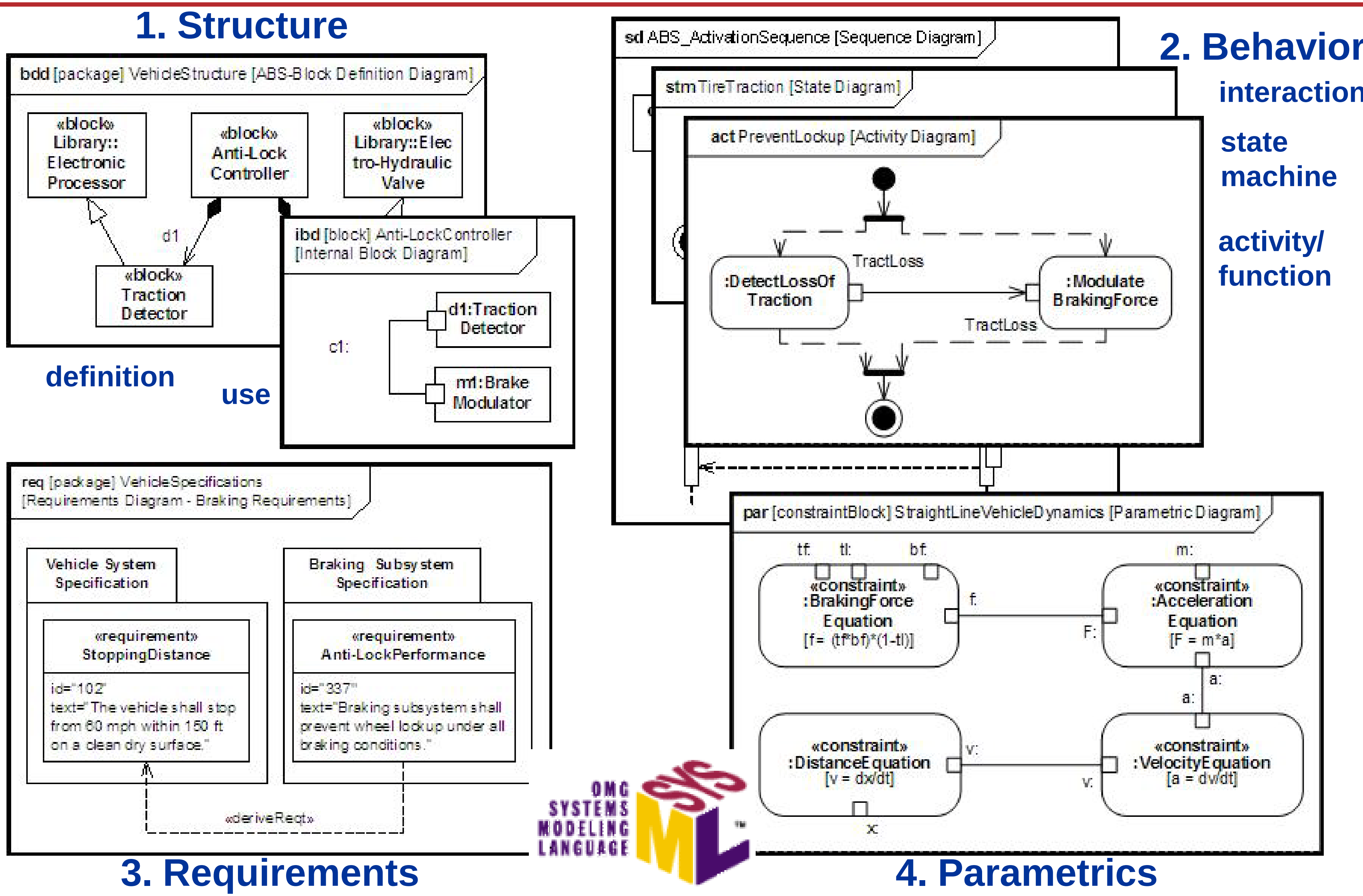
The Four Pillars of SysML



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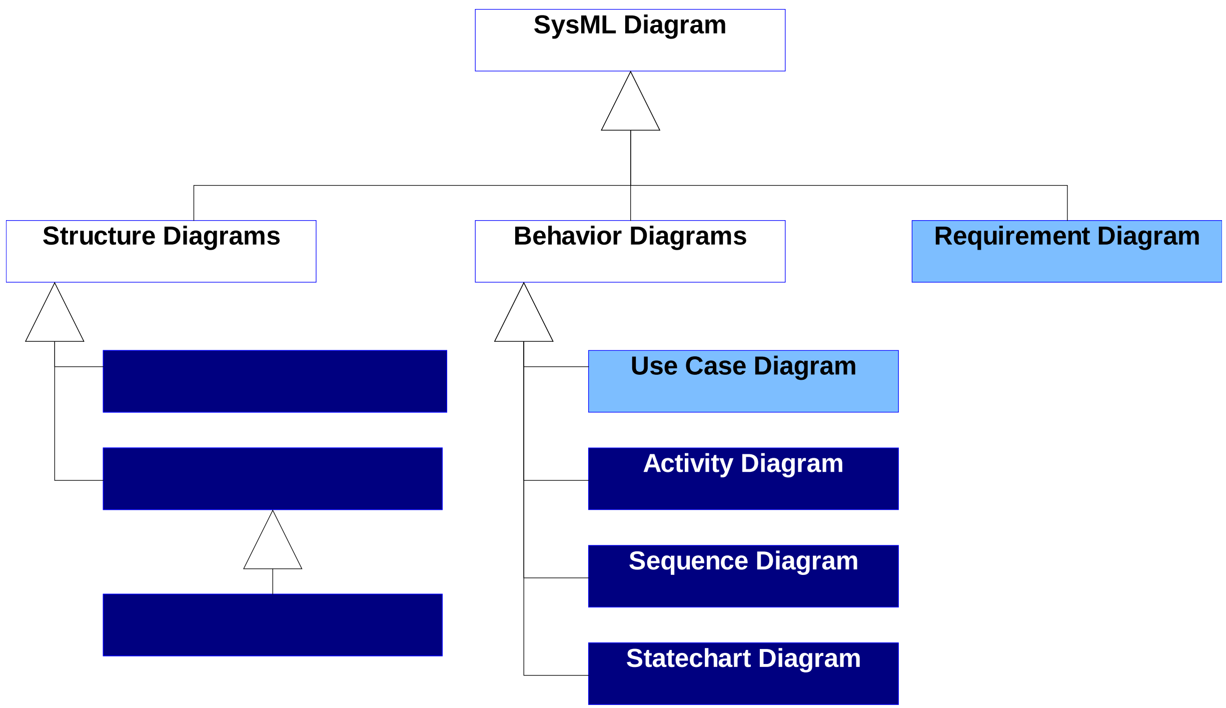
Version 1.0

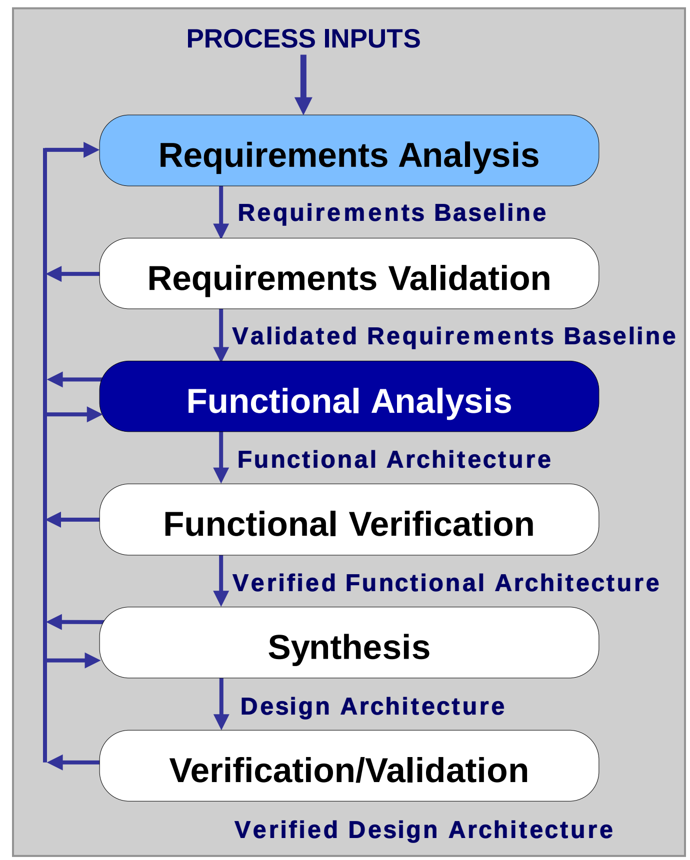
GENERAL DYNAMICS

SysML Diagrams Represent System Engineering Views

- **SSCI members are interested in how SysML supports key system engineering processes for requirement, functional analysis, and more**



IEEE 1220 SE Process



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GDLS MDE-Related Improvements

- **Use of storyboards addressing need for better CONOPS that are easy to understand and relevant to stakeholders – tailored activity diagrams**
- **Generation of sequence diagram with automation to move derived requirements to be linked during process of elaborating sequence diagram**
    - — Efficiency and completeness step to ensure derived requirements moved to sequence diagram, where traceability links are added
- **Allows for automated movement of requirements to DOORS®**
- **Validation through execution**
- **Allows for automated generation of measurement data for status/measurement of the analysis activities**

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Technology Adoption Recommendation

- **Don’t “jump” into projects without determining how to use MDE tools**
  - One SSCI Member said: “after training we know how the tool works, but we don’t know how to produce work with the tools”
- **Use pilot projects first to understand the “real” value of artifacts produced by tools**
- **Don’t over estimate value of results in comparison to effort needed to put tools and processes in place**
- **Align proposals with new types of deliverables**
  - It takes more time to produce models for an SRR or SFR than it does using a document-centric approach
  - Documents can be incomplete (“good enough”) for reviews, but inconsistent or incomplete models cannot
- **Prepare for tool evolution (version upgrades)**

Talk with Customer About Technology, Process, and Deliverable Changes

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- **Typical SRR and SFR (PDR/CDR) are based on traditional document-centric and waterfall lifecycle**
- **Model-based approaches result in artifacts that can contribute to multiple reviews, and can contribute downstream (e.g., V&V)**
- **Internal and external stakeholders need to understand that model-driven upfront work is superior to document-centric analysis**
- **Successful SSCI member example:**
  - — Organization adopting new modeling practices brought customer in for multi-days review of new approach and deliverables
  - — Customer recognized increased details in model-based artifacts that typically don't exist with document-based processes
  - — Customer understood how details would be beneficial over entire development lifecycle
  - — Customer was pleased and wanted to know why other projects were not using modeling approach

Points to Remember

- **Integrated engineering is challenging, but needed as impacts of functional analysis decisions can cut across subsystems**
  - — MDE can provide many efficiencies and help link functional analysis information so that impacts can be identified faster and more easily
- **Technology adoption**
  - — Evolving from document-centric to model-centric approach requires coordination with stakeholders
    - – Models can take longer to develop, especially the first time
    - – Models identify issues early and provide other downstream value
  - — Technology readiness can impact MDE adoption:
    - – Know what/how models map to current processes
    - – Understand tool value derived from operating on models
    - – Understand how tool chains can support the entire life cycle
    - – Use pilot projects to prepare for adoption
- **Consider discussing technology and process evolution changes with customers/stakeholders**

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For More Information

- **Questions on MDE**
  - — Contact Mark R. Blackburn, Ph.D.
  - — 561.637.3452; blackburn@systemsandsoftware.org
- **General questions, products, services**
  - — Main Consortium number 703.742.8877
  - — Home page www.systemsandsoftware.org

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Terms and Acronyms

AADL	Architecture Analysis & Design Language
AP233	Application Protocol 233
BPML	Business Process Modeling Language
CAD	Computer-Aided Design
CASE	Computer-Aided Software Engineering
CATIA	Computer Aided Three-dimensional Interactive Application
CDR	Critical Design Review
CMM ®	Capability Maturity Model
CMMI ®	Capability Maturity Model Integration
CONOPS	Concept of Operations
CWM	Common Warehouse Metamodel
DBMS	Database Management System
DoDAF	Depart of Defense Architectural Framework
DSL	Domain Specific Languages
GDLS	General Dynamics Land Systems
IBM	International Business Machines
ICD	Interface Control Document
IEEE	Institute of Electrical and Electronics Engineers
INCOSE	International Council on Systems Engineering
IPR	Integration Problem Report
ISO	International Organization for Standardization
IT	Information Technology
Linux	An operating system created by Linus Torvalds
MAP	Modeling Adoption Practices
MARTE	Modeling and Analysis of Real Time Embedded systems
MATRIXx	Product family for model-based control system design produced by National Instruments
MBT	Model Based Testing
MDA®	Model Driven Architecture®
MDD™	Model Driven Development
MDE	Model Driven Engineering
MDSD	Model Driven Software Development
MDSE	Model Driven Software Engineering
MIC	Model Integrated Computing
MMM	Modeling Maturity Model
MoDAF	United Kingdom Ministry of Defence Architectural Framework
MOF	Meta Object Facility
NASA	National Aeronautics and Space Administration
OCL	Object Constraint Language
OMG	Object Management Group
OO	Object oriented
PDR	Preliminary Design Review
PIM	Platform Independent Model
Pro/E	Pro/ENGINEER
PSM	Platform Specific Model
RFP	Request for Proposal
ROI	Return On Investment
RTW	Mathworks Real Time Workshop
SSCI	Systems and Software Consortium
Simulink/ Stateflow	Product family for model-based control system produced by The Mathworks
SCR	Software Cost Reduction
SDD	Software Design Document
SE	System Engineering
SFR	System Functional Review
SME	Subject Matter Expert
SQL	Structured Query Language
SRR	System Requirement Review
SRS	Software Requirement Specification
SysML	System Modeling Language
SystemC	IEEE Standard 1666
UML	Unified Modeling Language
XMI	XML Metadata Interchange
XML	eXtensible Markup Language
xUML	Executable UML
Unix	An operating system with trademark held by Open Group
VHDL	Verilog Hardware Description Language
VGS	T-VEC Vector Generation System
VxWorks	Operating system owned by WindRiver

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Technology Maturation for the Automated Aerial Refueling (AAR) Project

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Ba Nguyen, AFRL, AAR Chief Engineer

Jordan Adams, AFRL, AAR Systems Engineering Lead

Robert McCarty, SynGenics Corporation

Outline

- Early Systems Engineering (SE) in Acquisition
- Technology Maturation (Tech Mat) in Early SE
- AAR Program Background
- Tech Mat Planning for AAR

Outline

- **Early Systems Engineering (SE) in Acquisition**
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How Do AF and DoD Define Systems Engineering?

"Air Force SE involves comprehensive planning, management, and execution of rigorous technical efforts to develop, field, & sustain robust products and systems…

- ***SE collects, coordinates, & ensures traceability of all stakeholder needs into a set of system requirements through a balanced process that takes into account effectiveness, performance, cost, schedule, and risk."***

AFI 63-1201, *Life Cycle Systems Engineering*

- Technical Planning
- Requirements Mgt
- Interface Mgt
- Risk Mgt
- Configuration Mgt
- Technical Data Mgt
- Technical Assessment
- Decision Analysis

Integrated AT&L Life Cycle Mgt System, V.5.3.4, 15 Jun 09

When Does AF Say SE Should First Be Applied?

"Application of SE fundamentals must begin with concept inception, and must cover all efforts across all life cycle phases, to include sustainment & disposal, for all Air Force products & systems.

Early SE provides an audit trail from the users' capability gaps & needs, through concept selection, high-level system requirements refinement, & documentation of development plans."

AFI 63-1201, *Life Cycle Systems Engineering*

AFRL/CC will ensure incorporation of SE methodologies tailored for AFRL technology development done in support of evolutionary acquisition programs.

AFI 63-101: Acquisition & Sustainment Life Cycle Management

Science & Technology (S&T) Role in Early SE

AF *Early Systems Engineering Guidebook* (v1, Mar 09) *states the following:*

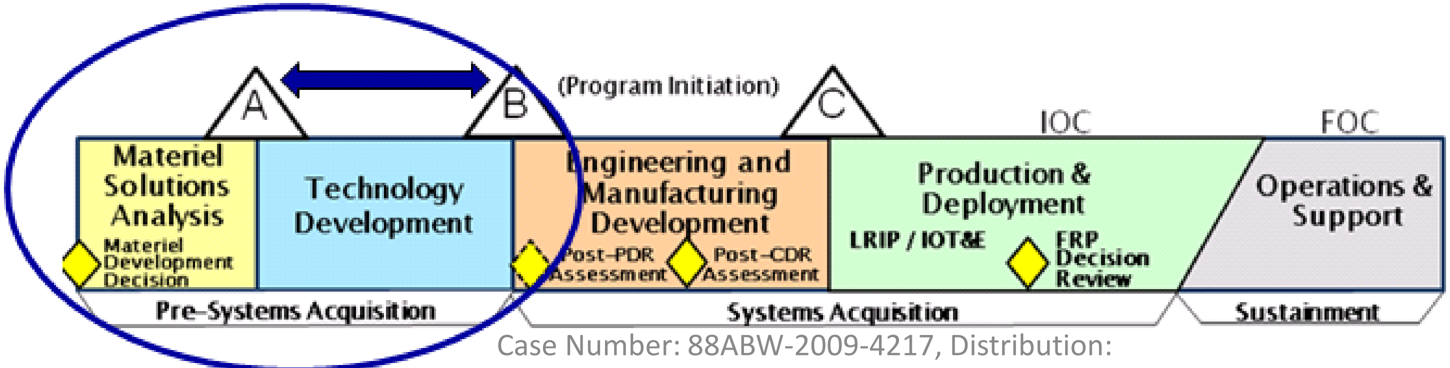
A technology organization, typically AFRL, works with acquisition organizations to ensure:

- Relevant technologies are considered, and that they are compatible with the desired time frame and expressed acceptable risk levels
- New approaches made possible by emerging technologies, as well as technologies that will improve a system's effectiveness and/or reduce its cost, are suggested
- Risks and uncertainties associated with new technologies are estimated, and impacts are assessed
- Insight as to user/operator needs is gained, allowing technologists to better focus their technology roadmaps

Does Early SE Pay Off?

2006 Defense Acquisition Performance Assessment (DAPA) Project Report Survey states:

- 96% of respondents cited at least one of the following three areas as critical to maintaining program cost, schedule, and performance (shown in ranked order):
  - **Requirements instability**
  - **Funding instability**
  - **Tech maturity**
- The greatest trade space, and thus the largest risk reduction opportunity, exists between Milestones (MS) A and B



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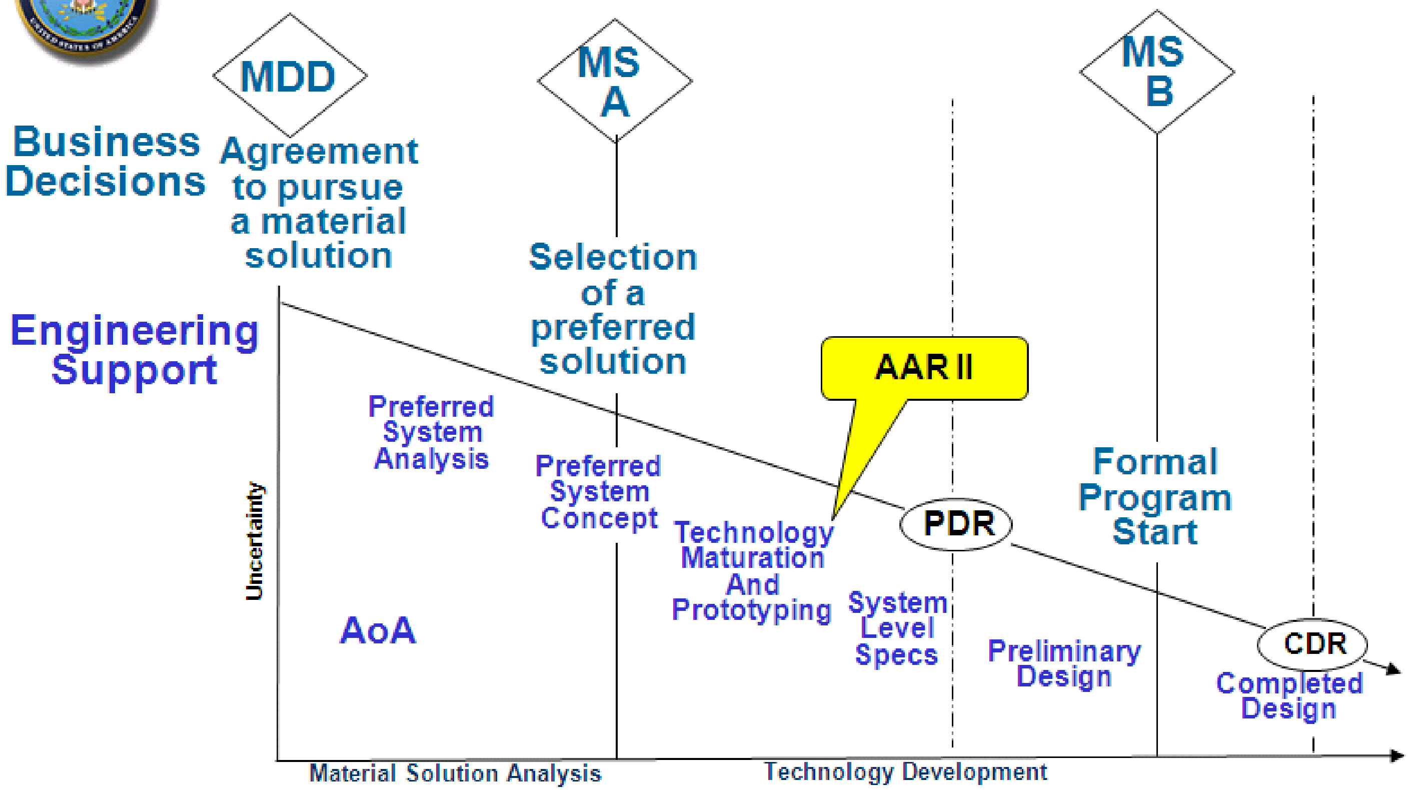
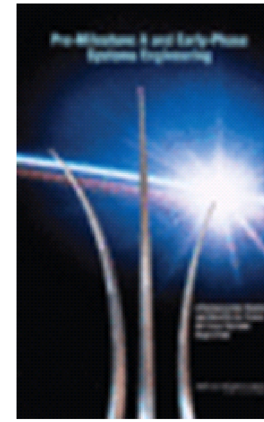
SE Provides a Technical Foundation for Acquisition





"Pre-Milestone A and Early-Phase Systems Engineering" Jan 2008

Systems Engineering is effective when it informs, and is informed by, other Acquisition process owners

Outline

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AAR Phase II
National AAR Team

Air Vehicles

Human Effectiveness

Sensors

Information

Case Number: 88ABW-2009-4217, Distribution: Approved for public release; distribution is unlimited

AARII Team Combines War fighters with Nationally Recognized Technologists

Significance to Air Force

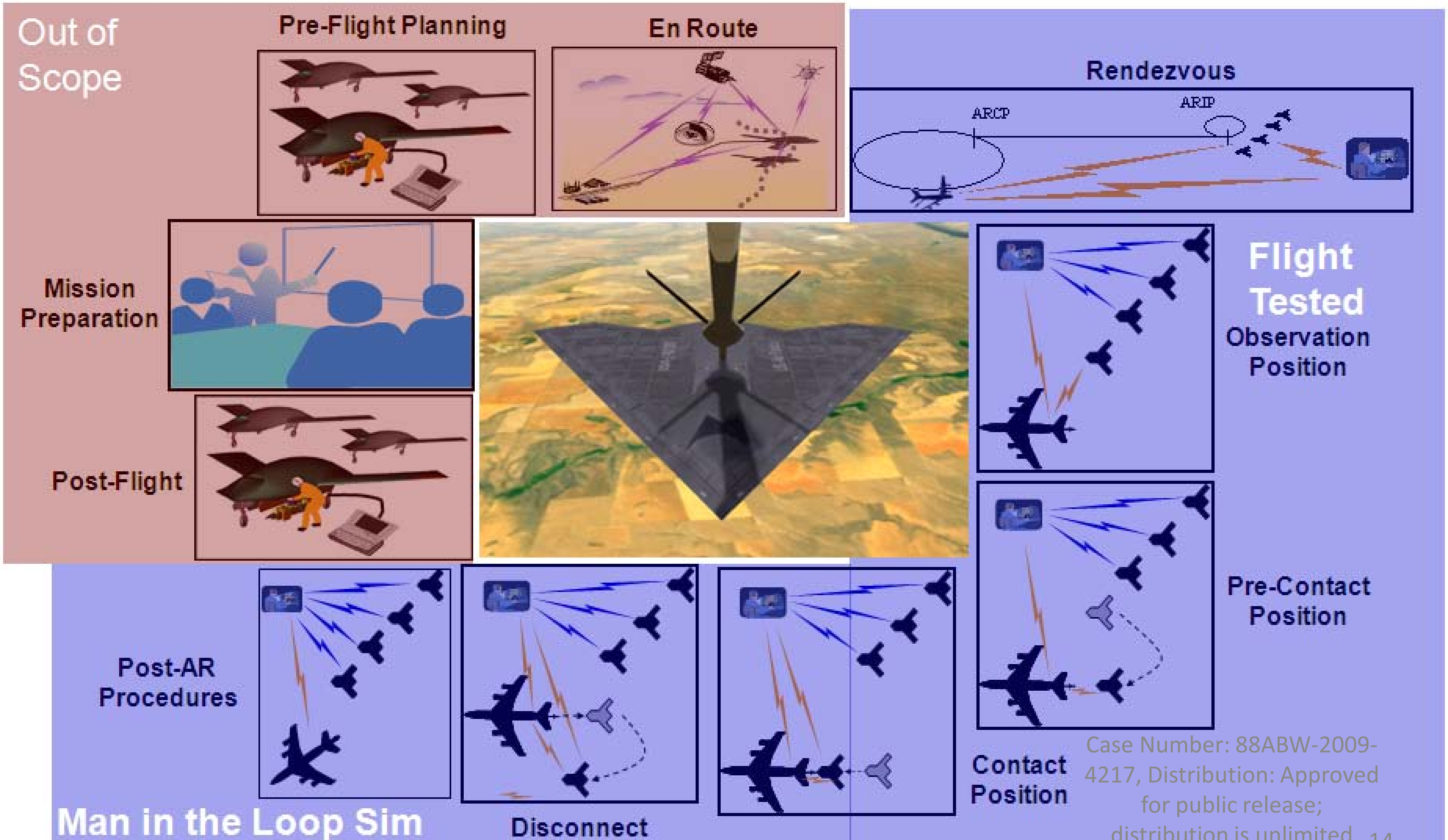
- **Unmanned Aerial Vehicles**
  - Extends Range
  - Shortens Response for Time-Critical Targets
  - Maintains In-Theater Presence Using Fewer Assets
  - Allows Deployment with Manned Fighters and Attack Without the Need of Forward Staging Areas

> ***"How does it (J-UCAS) air refuel? … which is persistence and endurance, things men can't do in airplanes"***
>
> **-Gen. John Jumper, USAF, February 2005**

- **Manned Aircraft**
  - Provides Adverse Weather Operations
  - Improves Fueling Efficiency
  - Improves Pilot Workload

AAR Assists UCAVs in Reaching Its Full Potential, and Greatly Enhances Manned Refueling

UCAS Mission/AR Overview

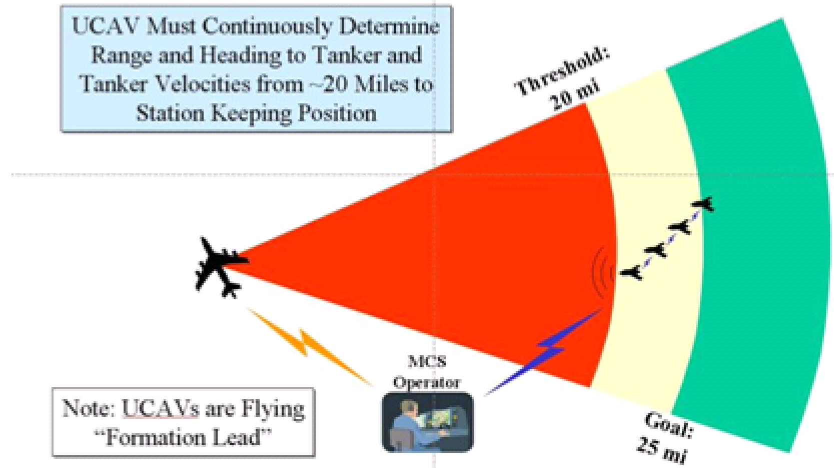


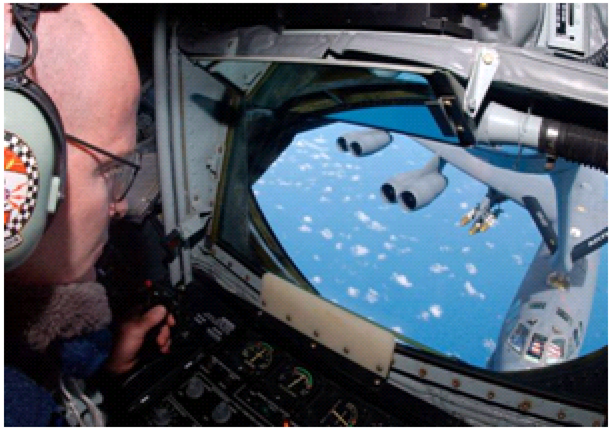
Key Technology Challenges

See Near
- Determine Relative Position with Tankers
  - Using Position/Velocities to Close Control Loop
  - High Confidence in Position Accuracy
  - Avoid Aircraft in AAR Area

Collision Avoidance
- AAR Brings Many Aircraft into Same Airspace

Command and Control
- Assure UCAS Accurately Responds Boomer Break-Away Commands





Aircraft Integration
- Minimize impacts to tanker fleet
- Fit within constrained volume of UCAS
- Precision control of UCAS
- Flight critical integration

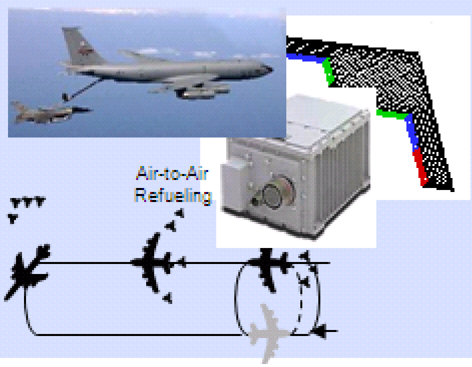
Real World Considerations
- Encryption, latency, drop-outs

AAR Spiral Approach to Technology Development

TRL 5

Spiral 0 – FY08

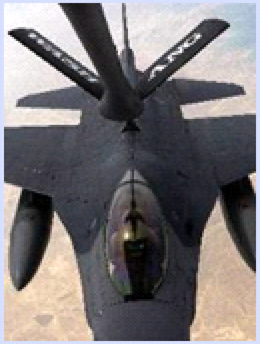
- **Technology Base Development**
  - Initial Specifications
  - ICDs and Architecture
  - Research PGPS Prototype
  - Fighter CONOPs
  - Sensor Augmented System Design/Requirements

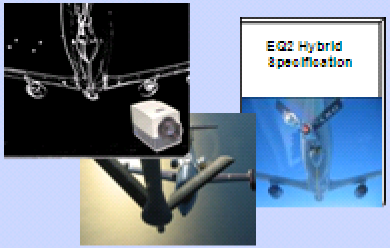


Spiral 1 – FY10

PGPS TRL 7

- **PGPS Adv Prototype Development**
  - PGPS Specifications
  - PGPS Prototype System
  - Bomber CONOPs



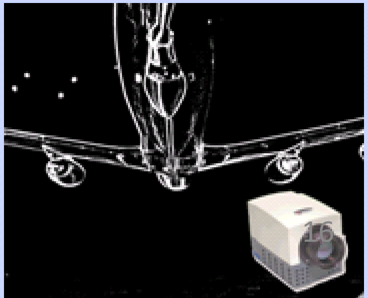


Hybrid TRL 5

Spiral 2 – FY12

- **Sensor Augmented System Tech Maturation**
  - AAR System Requirement
  - AAR Research Prototype
  - AAR Architecture/ICDs

Case Number: 88ABW-2009-4217, Distribution: Approved for public release; distribution is unlimited



Precision GPS Closed-Loop Station Keeping Flt Test Aug 06

- **Objectives:**
  - Evaluate updated Precision GPS (PGPS) performance
  - Test automated formation flight in contact position
  - Evaluate EO/IR camera as AAR sensor

- **Accomplishments:**
  - Simplex PGPS relnav and automated flight controls held Learjet in contact position for 23 continuous minutes
  - Over 4 hrs of "hands-off" formation flight
  - Over 85 minutes of "hands-off" contact position flight
  - Found sensor suitable for AAR

"The System Held Contact Position Better than I Could", Calspan Test Pilot

AAR UAS Surrogate

- VISTA Manned Surrogate
  - Autonomous Capability with Safety Pilot Override
  - Variable Stability Flight Controls

- Learjet Manned Surrogate
  - Autonomous Capability with Safety Pilot Override
  - Variable Stability Flight Controls

AAR Station-Keeping Flight Test
Example Contact Position Performance

Case Number: 88ABW-2009-4217, Distribution:
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Phase II AAR Test Plan

- **FY10 Precision RELNAV Open-loop Flight Test (PROFT) (Learjet)**
  - Simultaneously collect GPS data from multiple LN-251s for maturing GPS
  - Demonstrate the TTNT Redundancy Features on tanker
- **FY10 RELNAV Open-Loop Flight Test (Learjet)**
  - Verify fixes from PROFT
  - Evaluate EO/IR camera as AAR sensor
- **VISTA Inner-Loop Flight Test**
  - Characterize RELNAV Redundancy Architecture
  - Validate A/C model in VISTA
- **VISTA Station Keeping Flight Test (SKFT)**
  - Evaluate Precision GPS (PGPS) performance
  - Evaluate formation flight control System
  - Evaluate EO/IR camera as AAR sensor
- **VISTA Positions and Pathways Flight Test (PPFT)**
  - Demonstrate end-to-end AAR CONOPS mission including wet hookup and contingency
- **Full CONOPS Simulation**
  - Demonstrate full CONOPS with multiple tankers and receivers
  - Demonstrate mission control capability from AVO to receivers

Outline

- Early Systems Engineering (SE) in Acquisition
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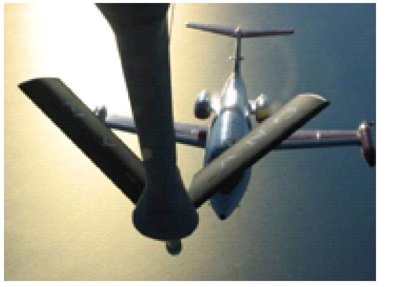
Key Technical Objectives for AAR Phase II

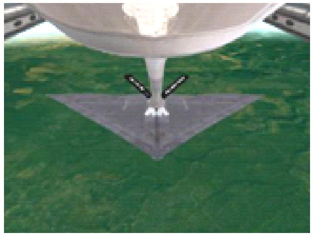
- **Reduce key risks to transition**
  - **Technical maturity, documentation, and impressions**
- **Mature AAR technology into a robust design, with supporting analysis and specifications**
  - **Safety, LO-compatibility, system health monitoring, FMECA, specifications**
- **Develop prototype system based on design demonstrating feasibility of design**
  - **Robust testing of prototype to determine adequacy of design and failure modes**

Automated Aerial Refueling (AAR) Phase II Way Forward

- Demonstrate AAR in a relevant environment through wet hookup

- Focus areas for further maturation
  - Redundancy/contingency management
  - Multi-ship operations
  - Sensor augmented (GPS+EO/IR Sensor) positioning system
  - Robust AAR System/CONOPS Simulation
  - Full AR CONOPS flight test with hookup





Critical Elements of AAR II Technology Maturation Planning

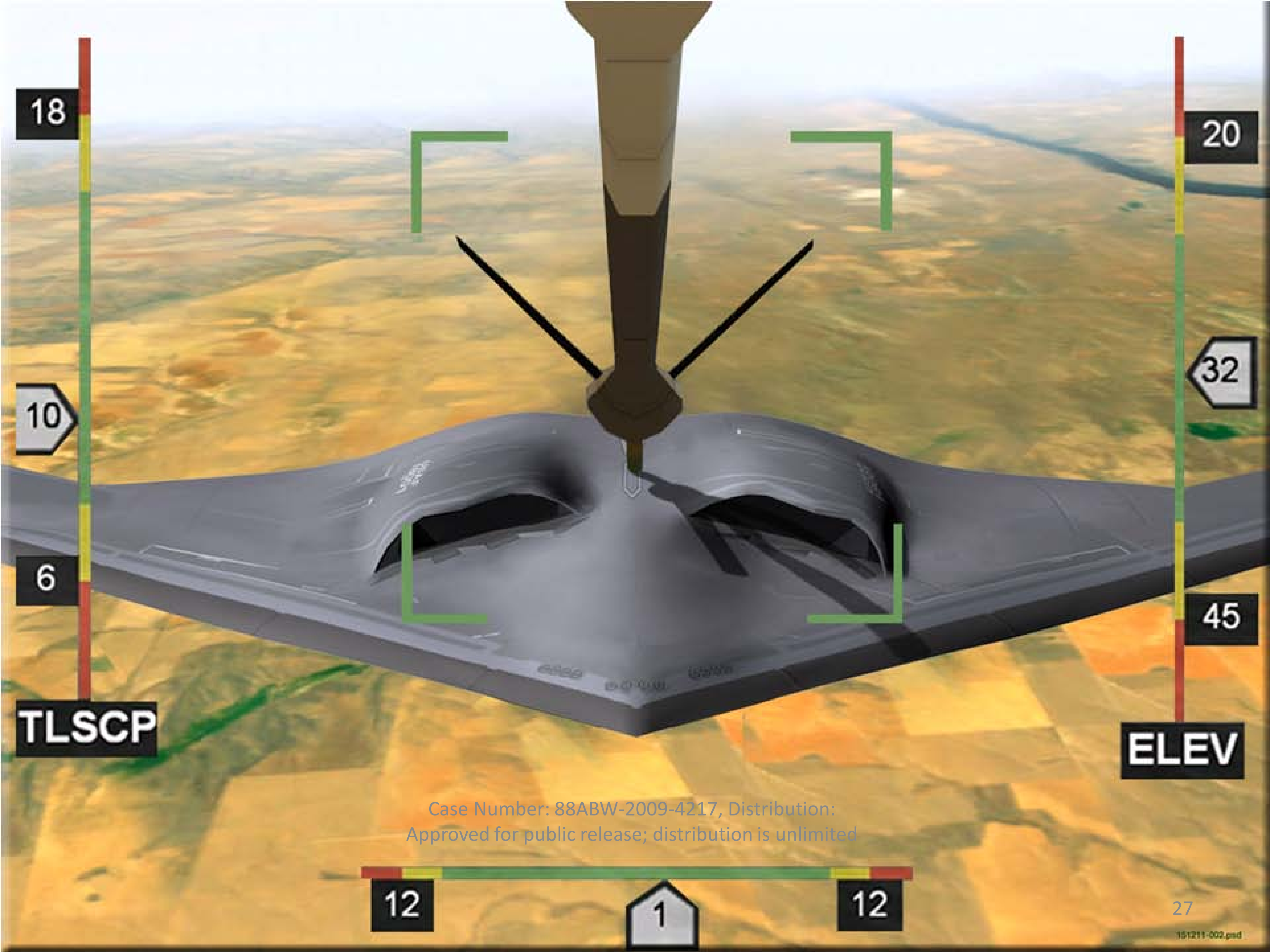
- Technology Participants
- Technology Demonstration Plan
  - Requirements Documentation
  - Program Objective
  - Approach
  - Technology Development Required
  - Applicable Systems
  - Product/Payoff/Exit Criteria
  - Programs/Activities Related to AAR Success
  - Programs/Missions Supported by AAR
  - Technology Milestones List
  - Technology Deliverables
  - Risk Analysis
  - Technology Protection Plan

Critical Elements of AAR II Technology Maturation Planning

- **Acquisition Strategy**
  - **Target Acquisition Programs**
  - **Stakeholders**
  - **Capability Document**
  - **Availability Dates for Technologies**
  - **Functional Strategies**
    - **Flight Qualification**
    - **Airworthiness Certification**
    - **Environmental Qualification**
    - **Logistics Support**
- **Technology/Acquisition Bridge**

Elements of Management Plan to Mature Requirements for AAR

- Process Flow
- Change Requests
- Requirements Change Control Board
- Tools
- Products
  - Baseline
  - Traceability
  - Verification Methods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CONSTELLATION TECHNOLOGY

Analyzing Your World

Upgrade Fluid System Filter Element Monitoring to Increase Operational Reliability and Support Condition Based Maintenance Capability

Presented by
Gary Rosenberg

October 29, 2009

Filter Monitoring Supports CBM

Why the filter element?

Filters are already incorporated in all important systems to provide operational reliability.

Fluid systems such as; Transmission, Lubrication, Hydraulic, Fuel and Electronic Cooling can utilize this effective CBM process.

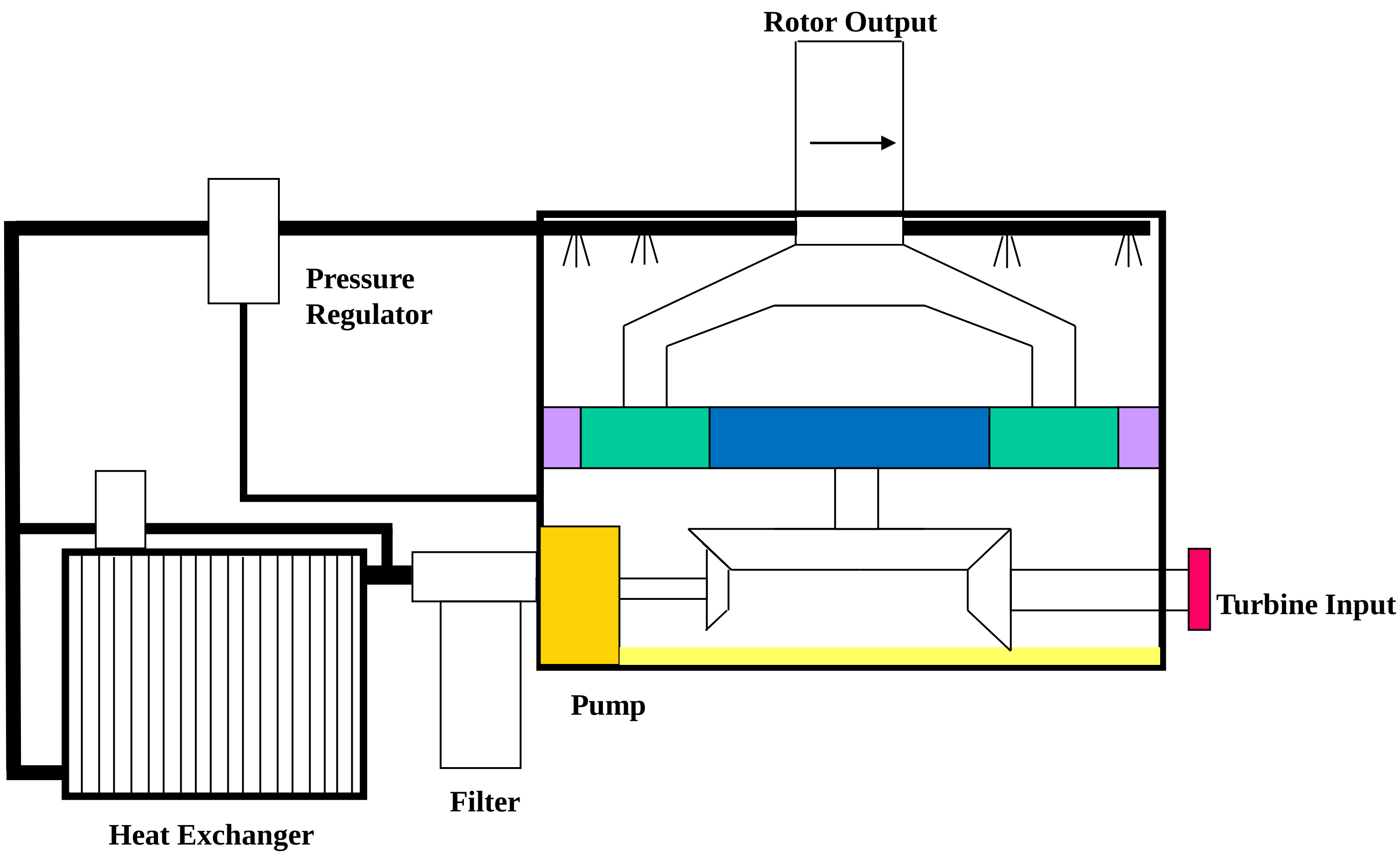
Filter Monitoring Supports CBM

In-System Filter Element Monitoring can support the following major levels of Condition Based Maintenance:

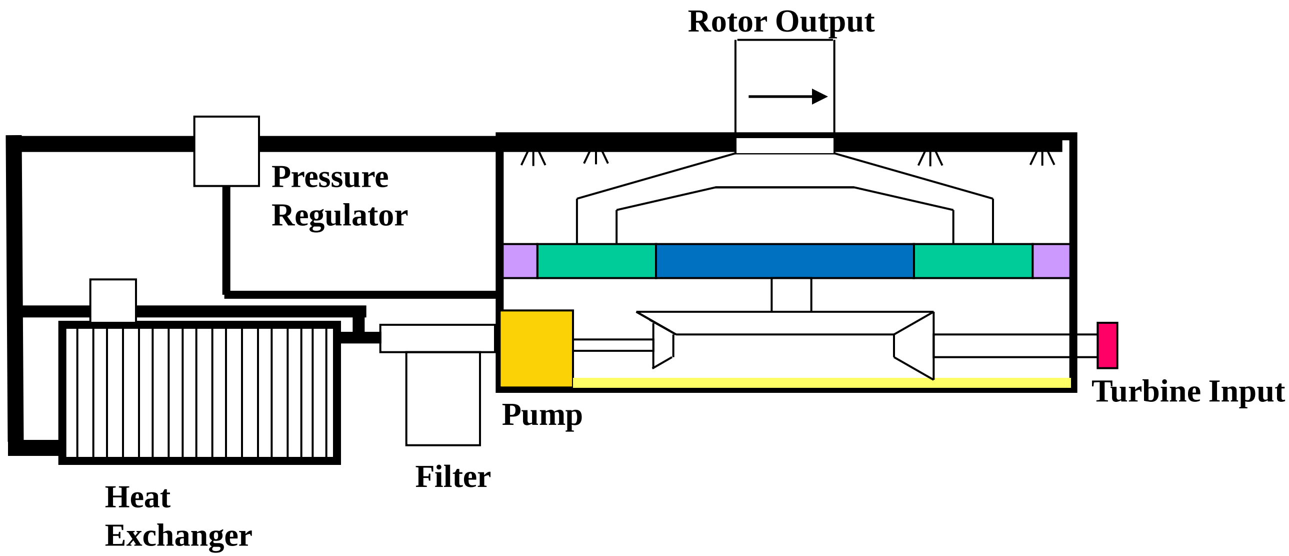
1. Identify when filter element service is required.
2. Determine the remaining filter element service life, the asset's mission availability and establish a schedule for filter element service.
3. Provide an early indication of a system fault.

Filter Monitoring Supports CBM

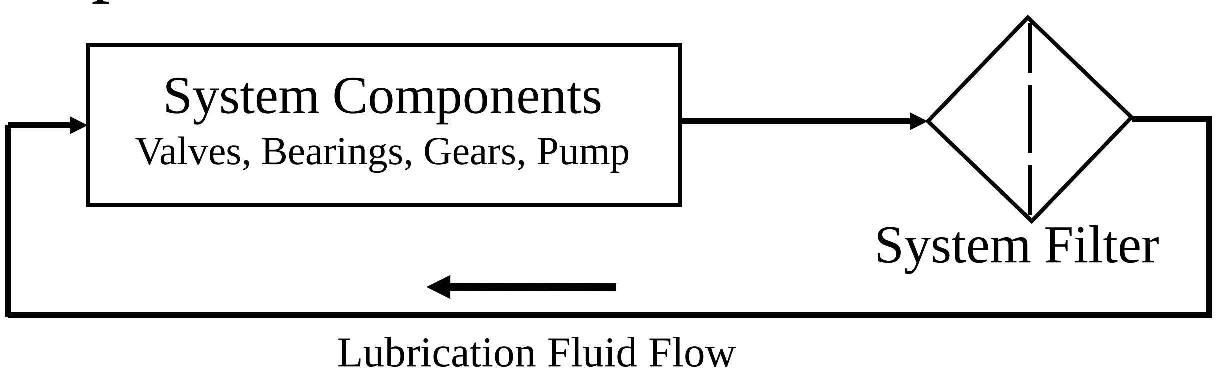
Basic Transmission Lubrication System



Filter Monitoring Supports CBM



System Simplification



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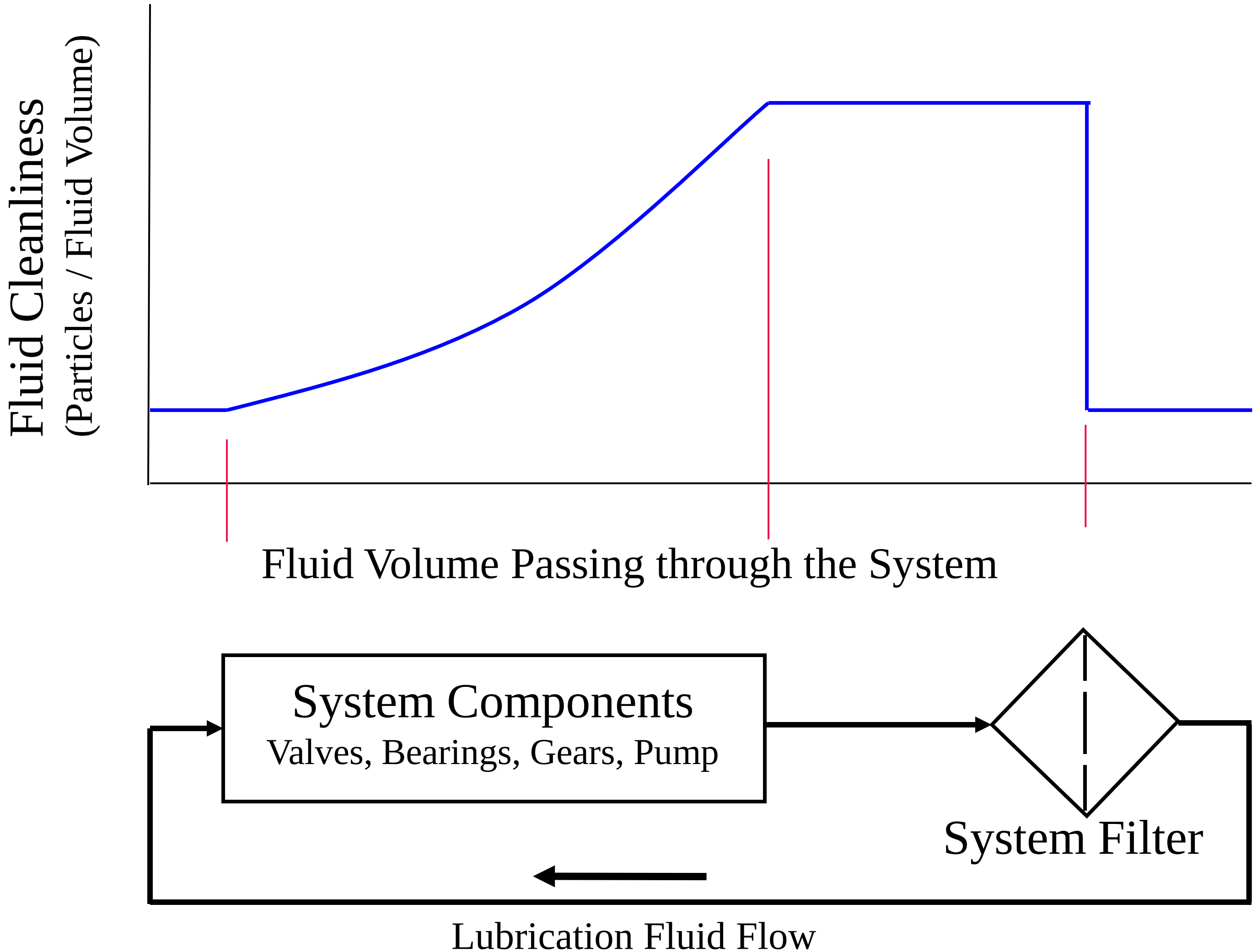

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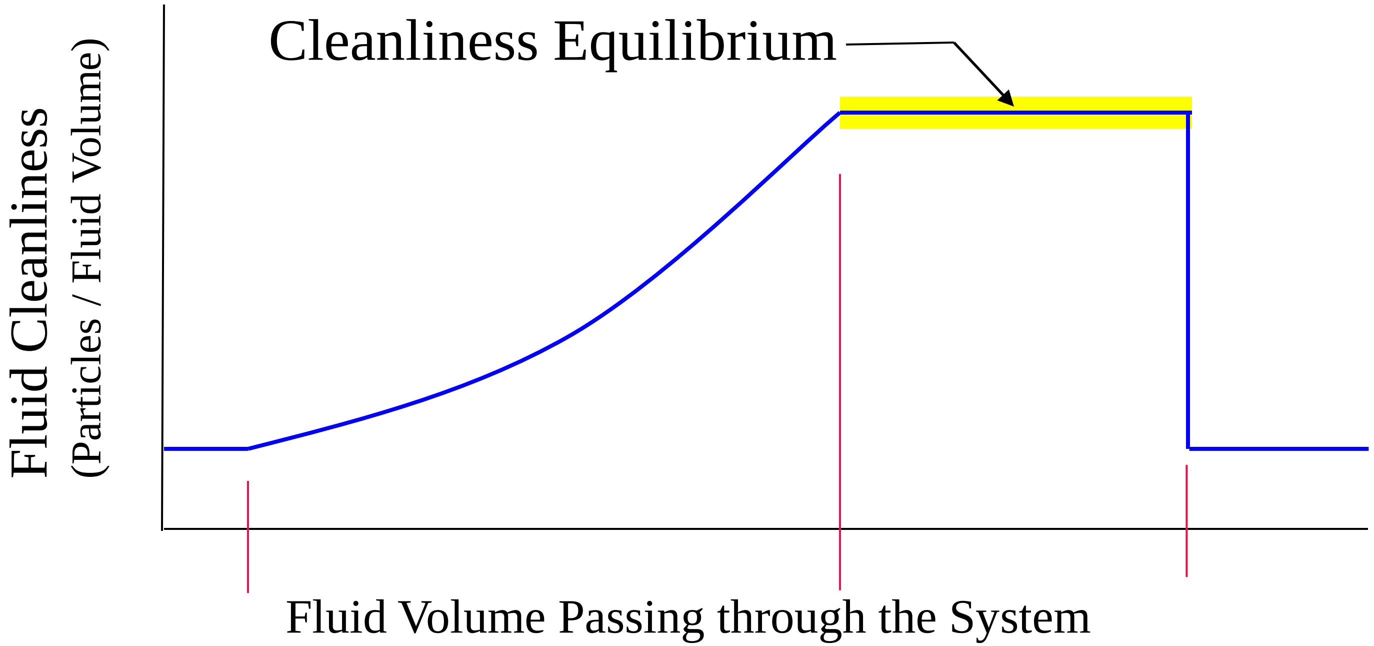

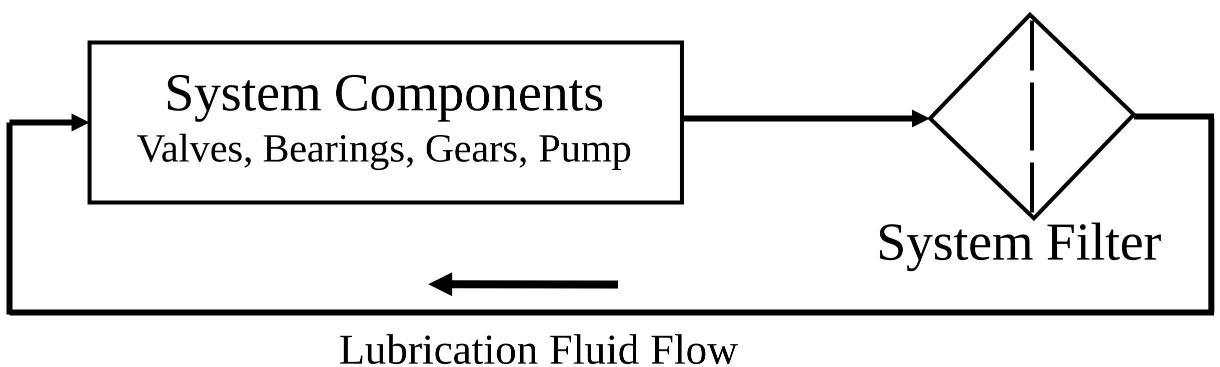

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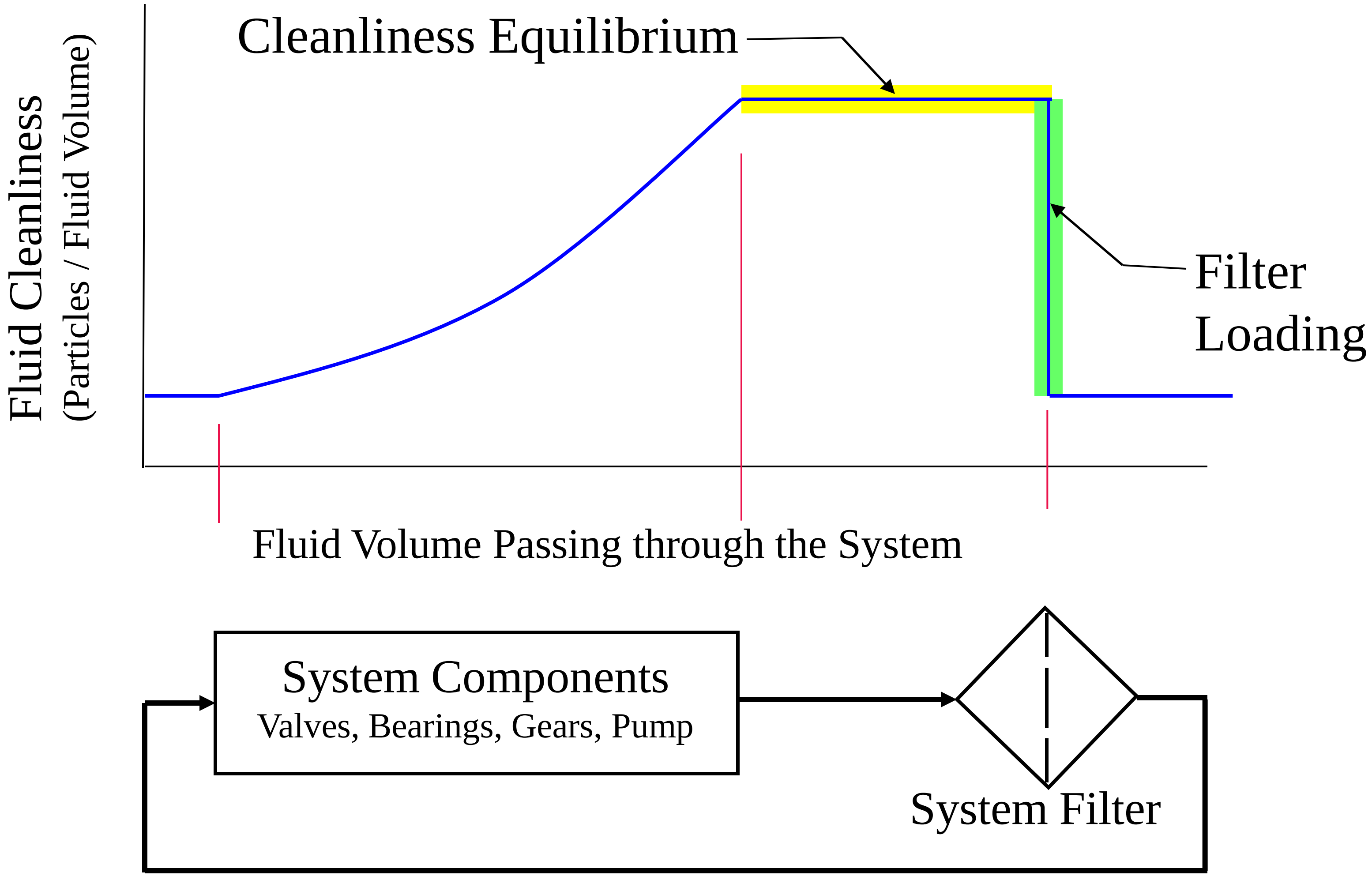
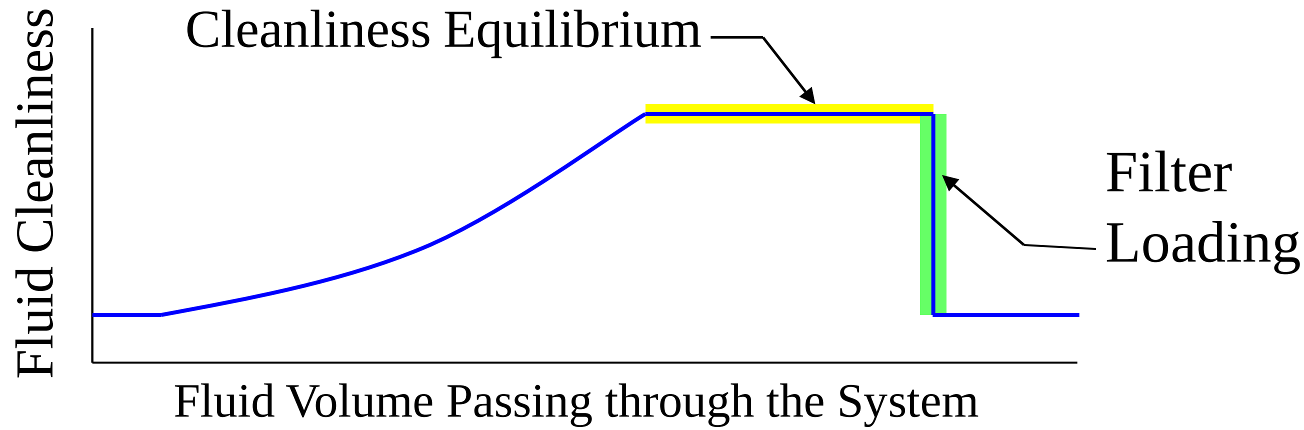
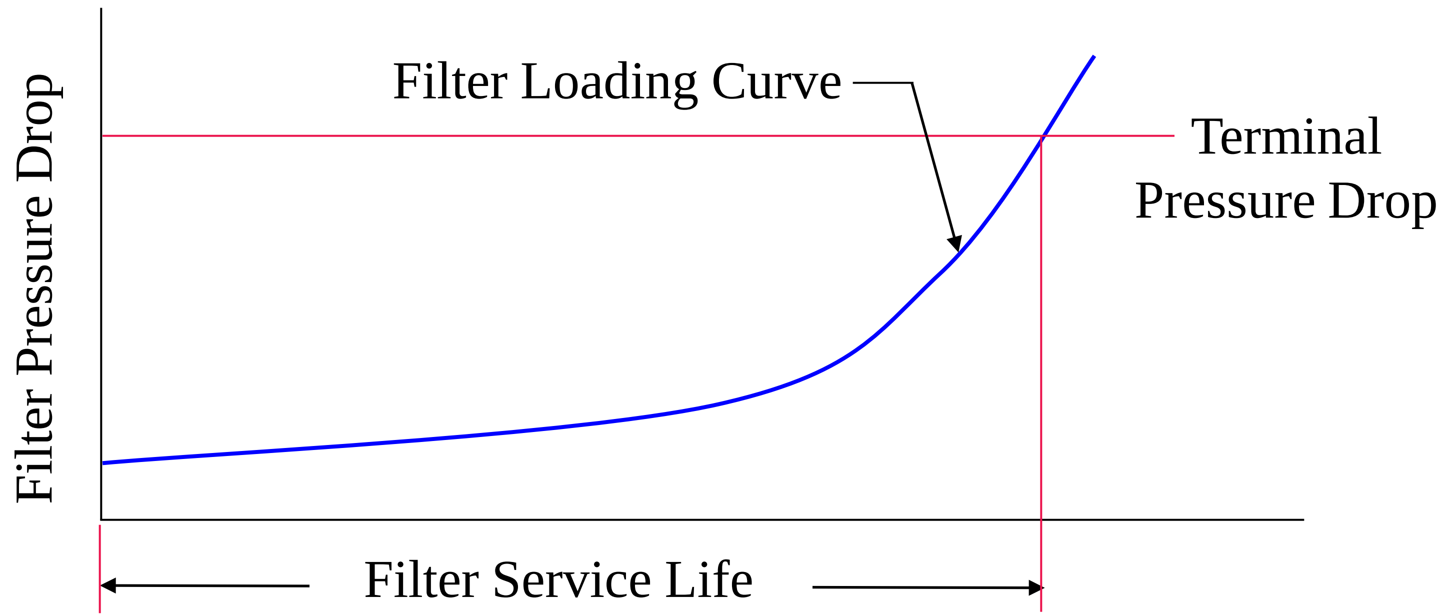


Filter Monitoring Supports CBM

Single Pass of Fluid Through The System



Sum of Filter Element Loadings Over Time



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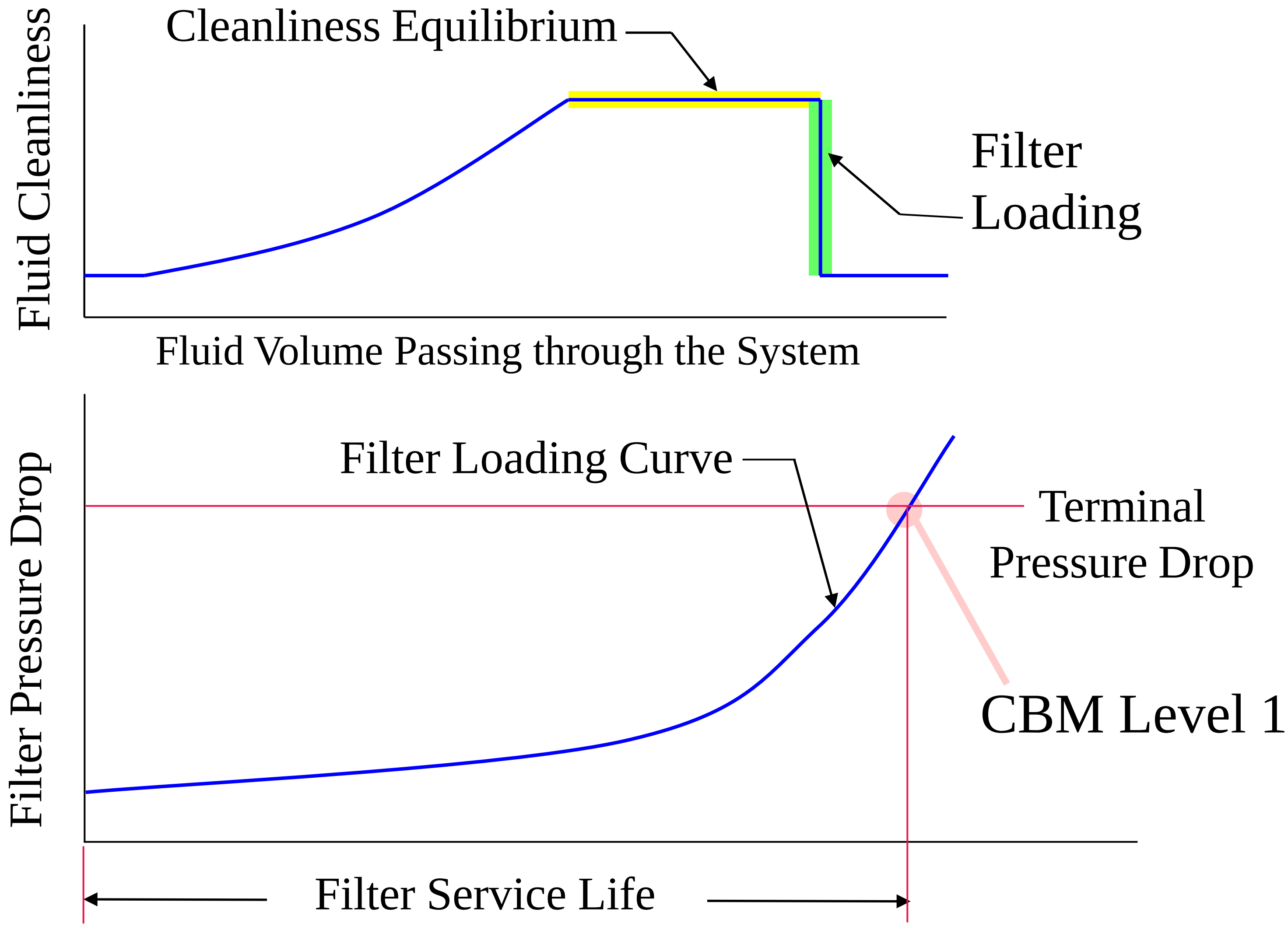
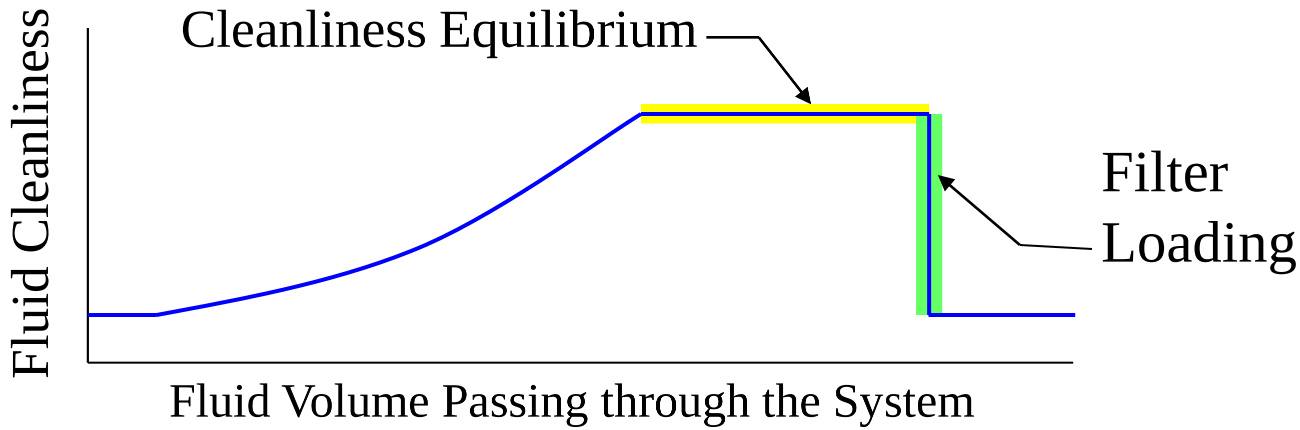


Filter Monitoring Supports CBM

Single Pass of Fluid Through The System



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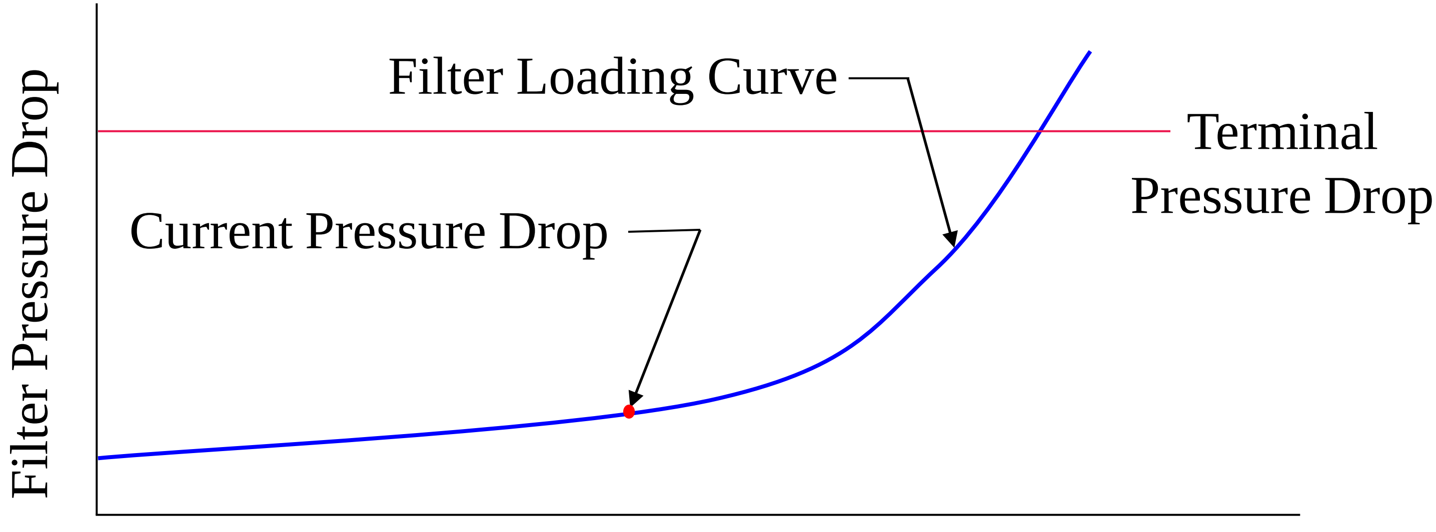

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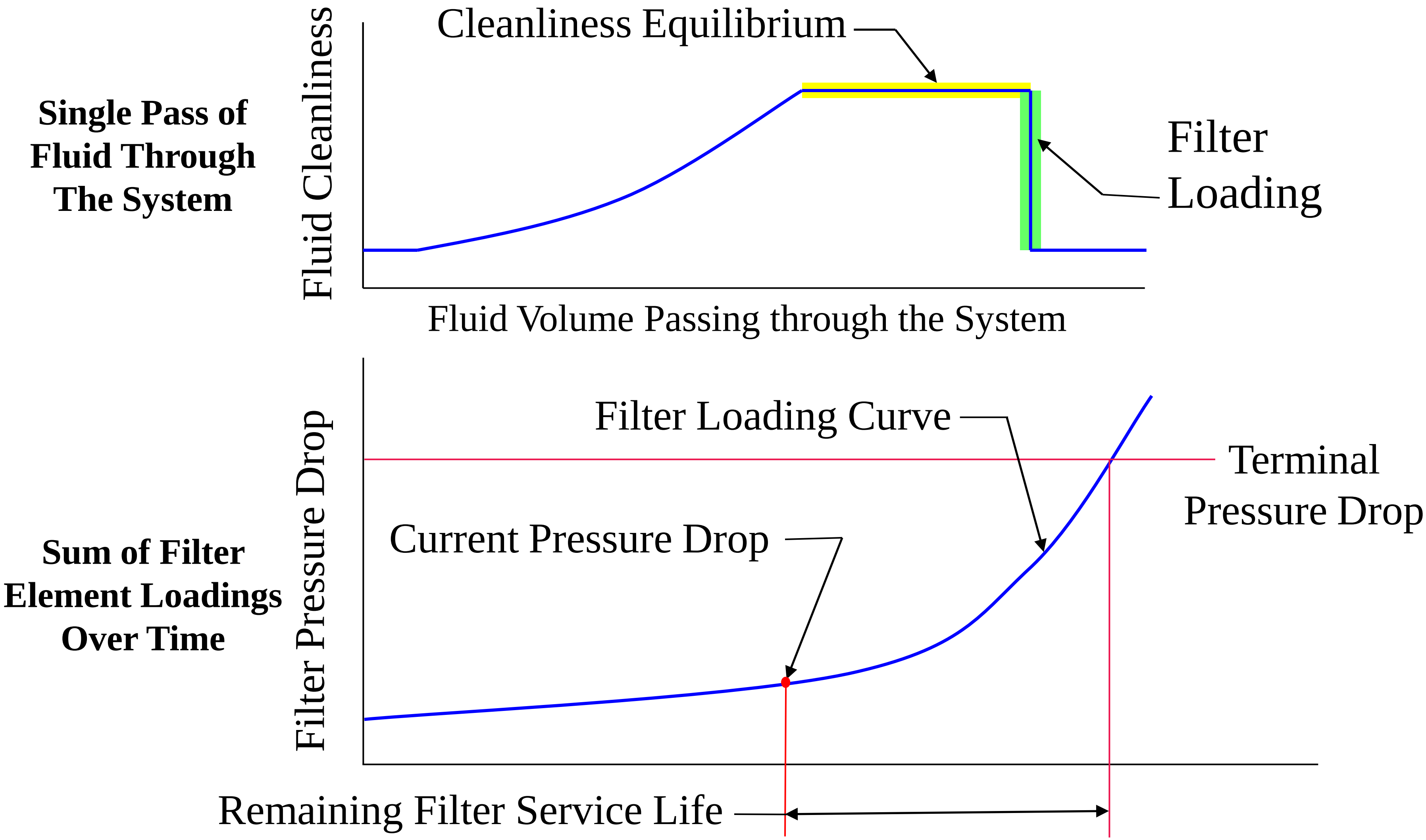

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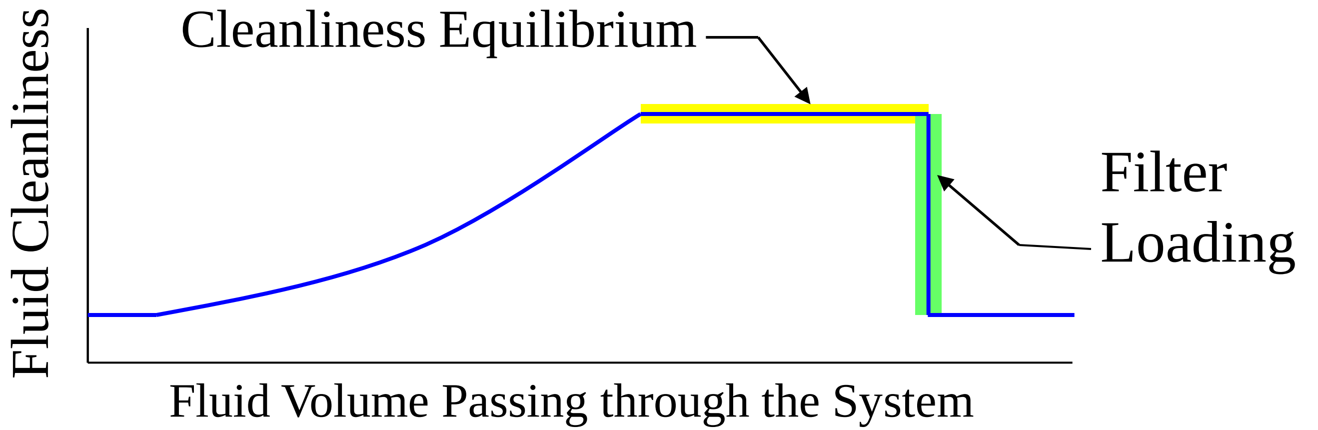

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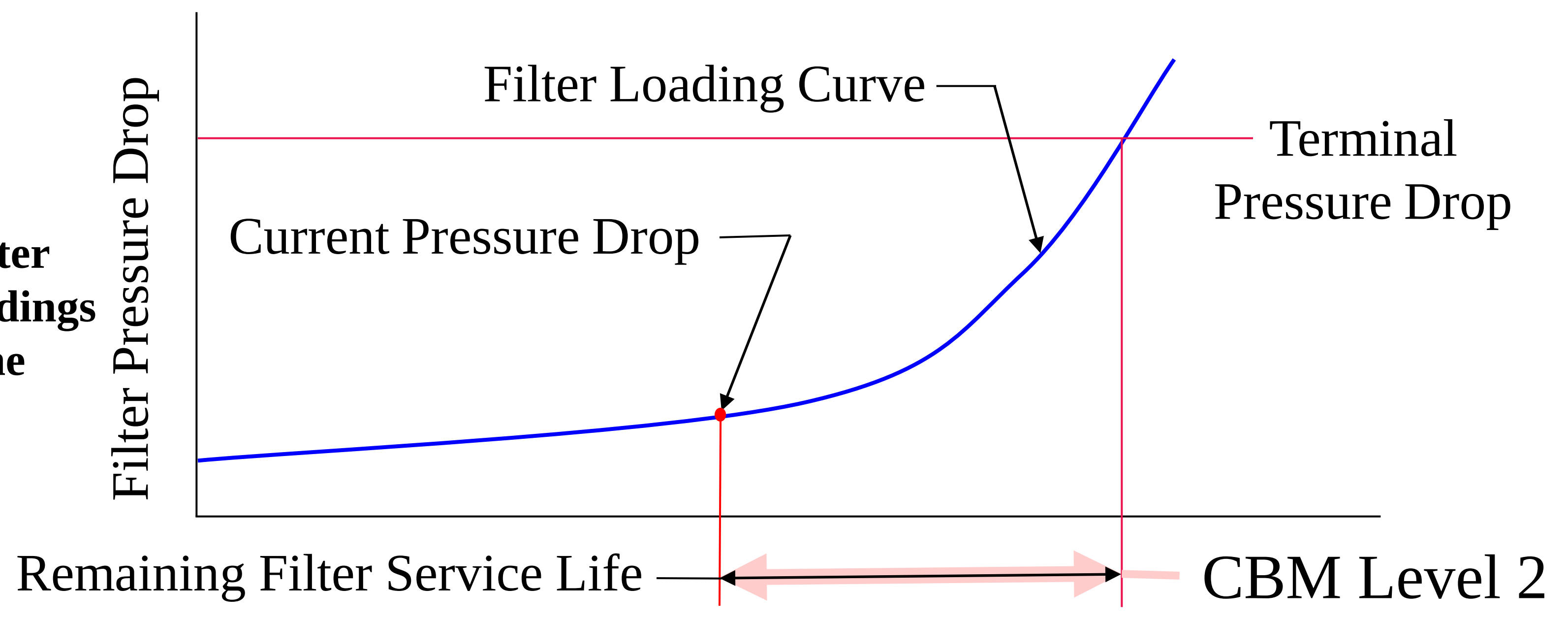
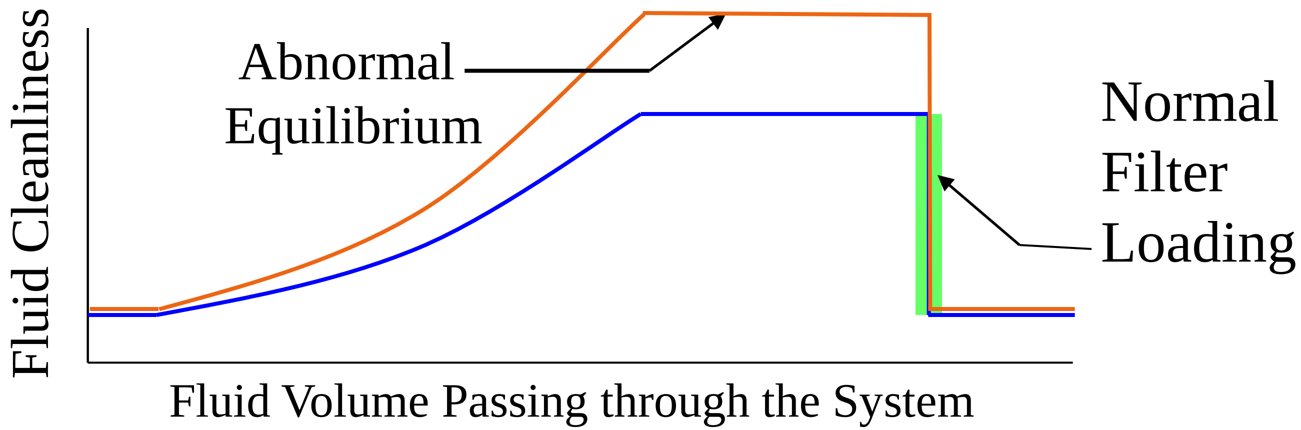


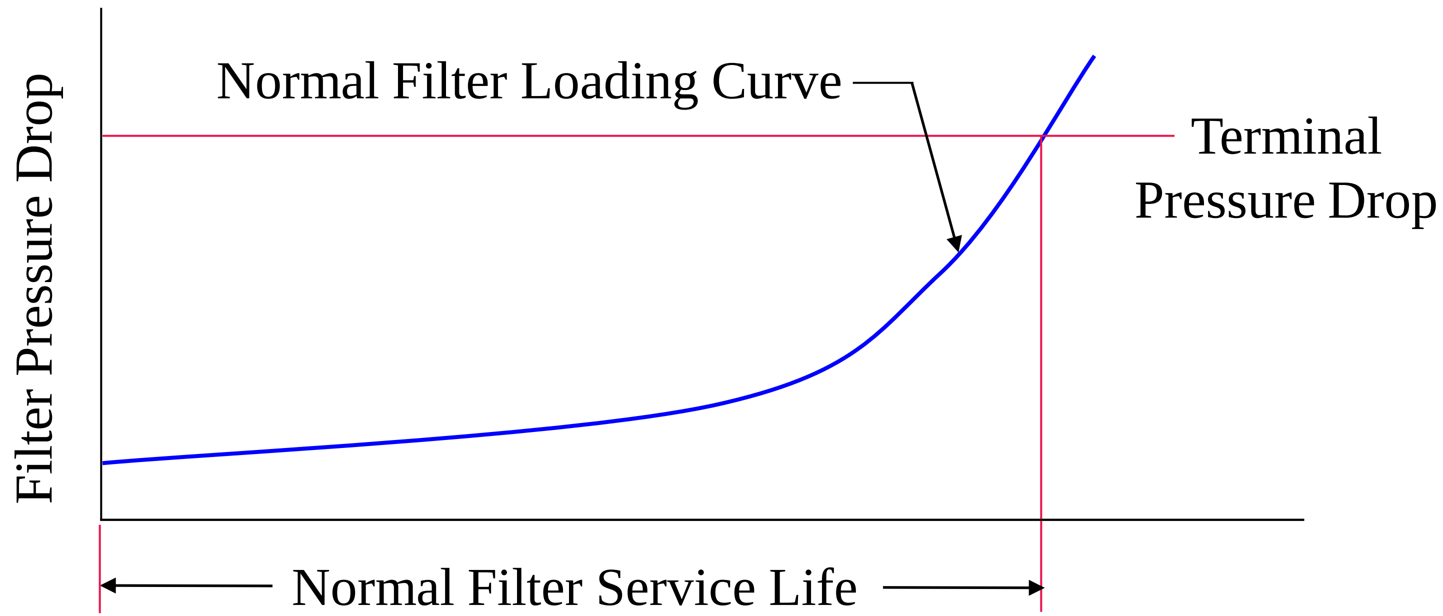
CONSTELLATION TECHNOLOGY
Analyzing Your World

Filter Monitoring Supports CBM

Single Pass of Fluid Through The System

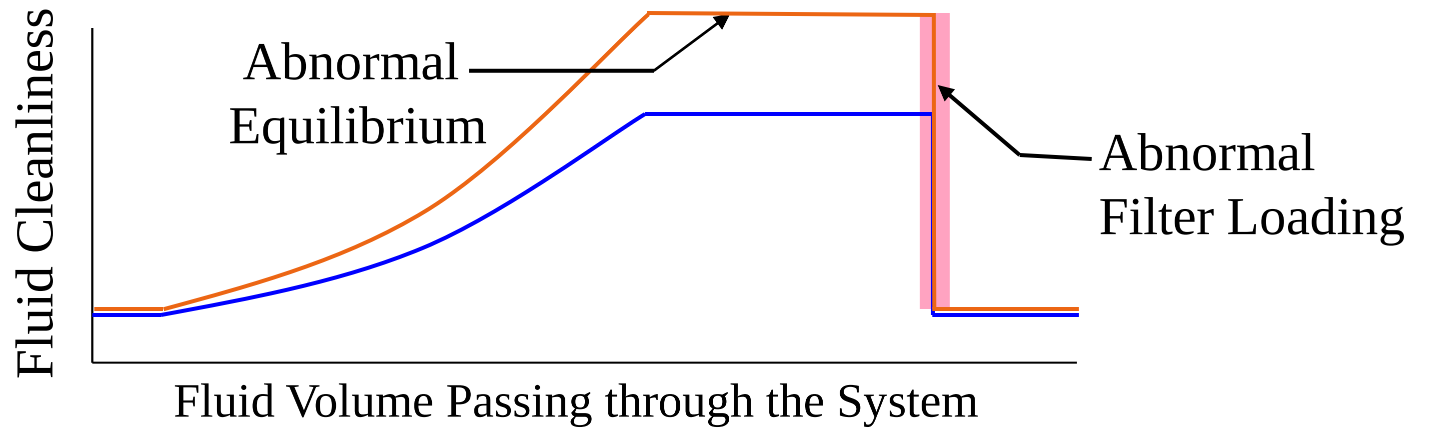


Sum of Filter Element Loadings Over Time



Filter Monitoring Supports CBM

Single Pass of Fluid Through The System



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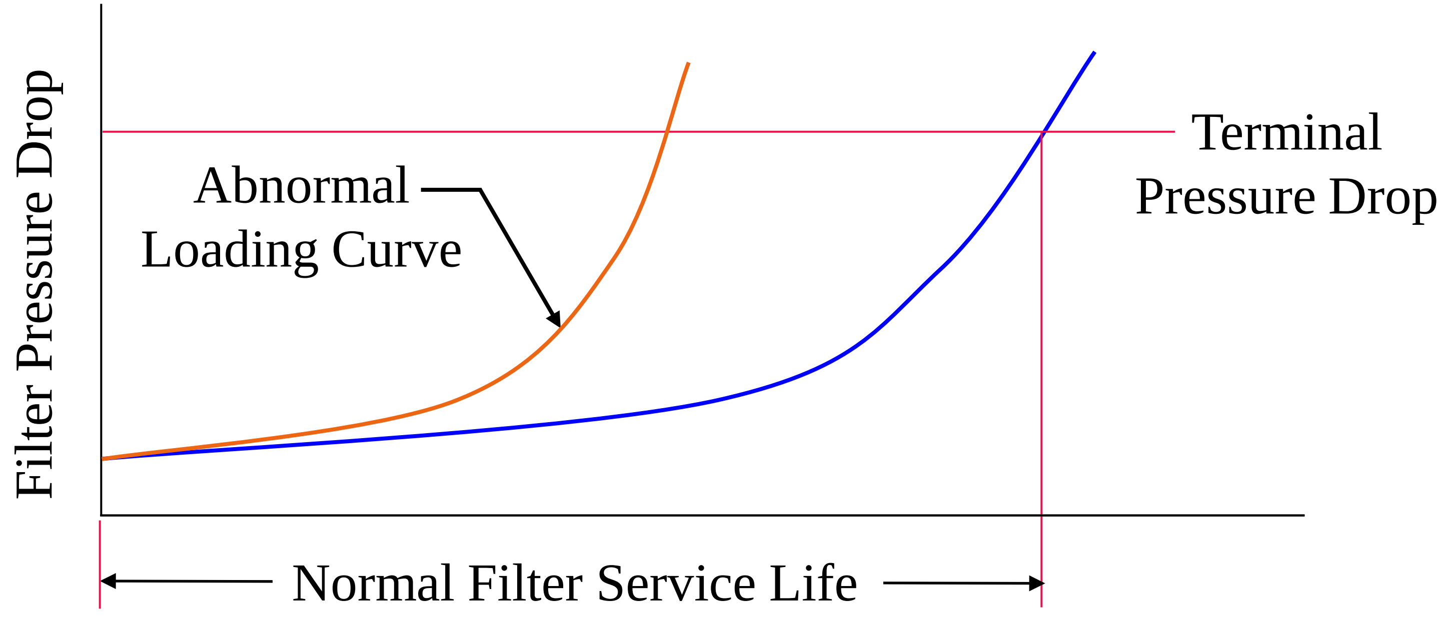

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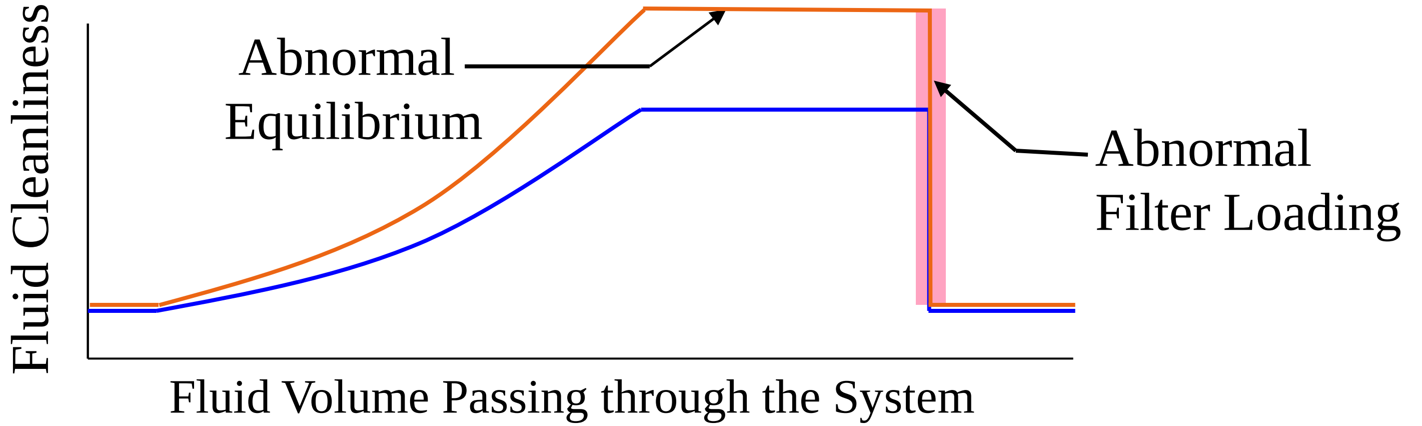

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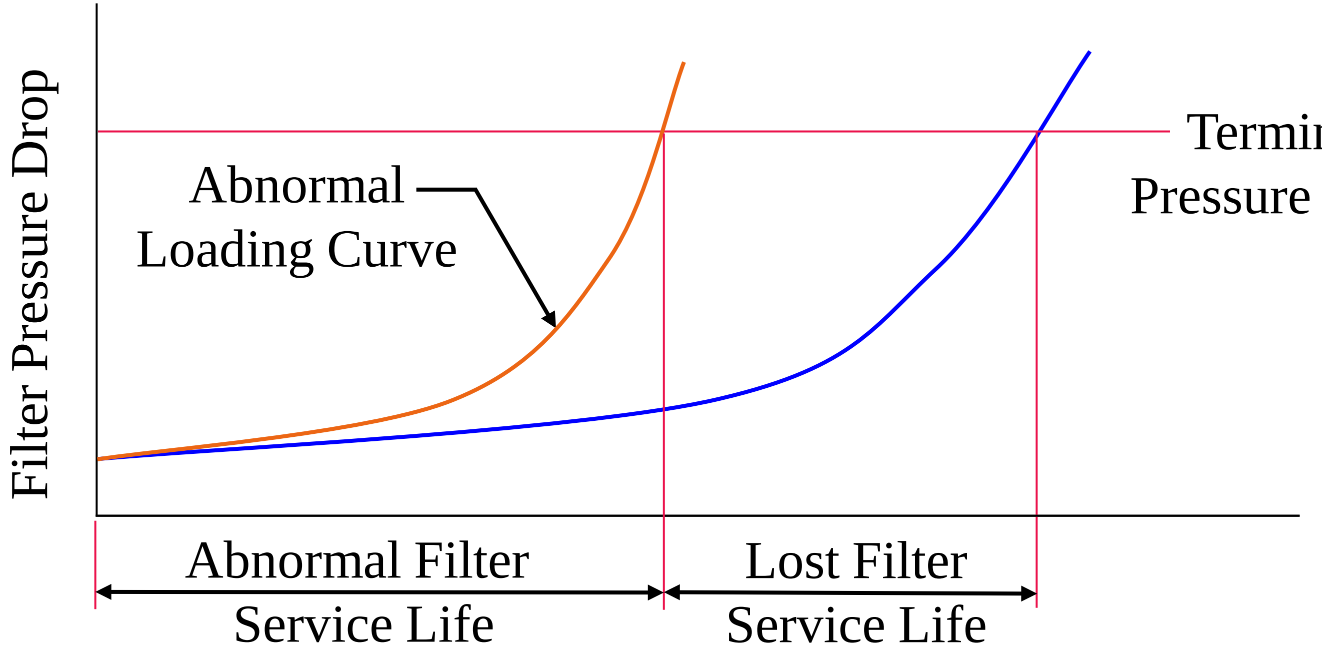

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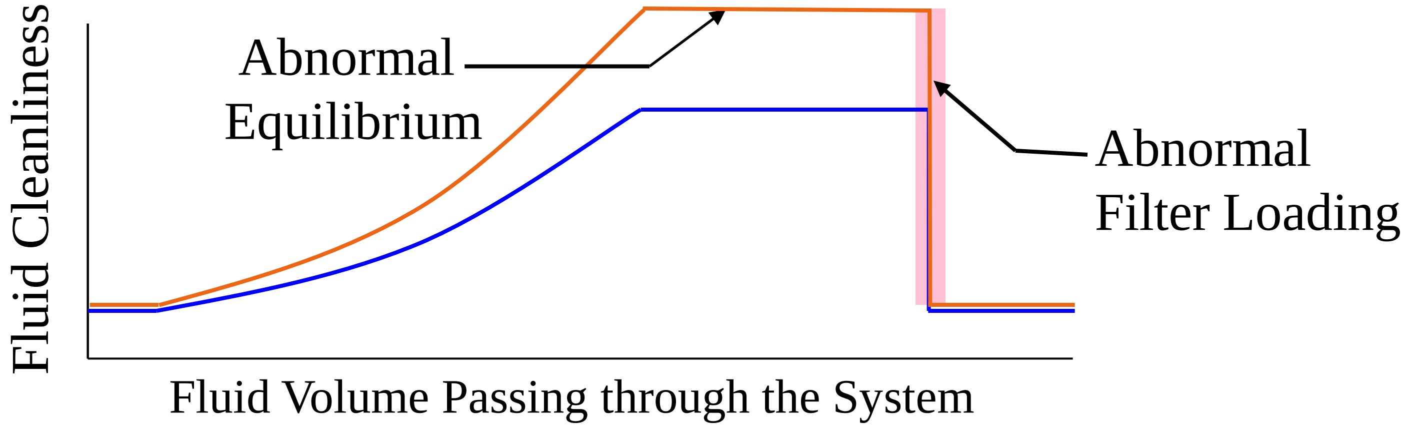
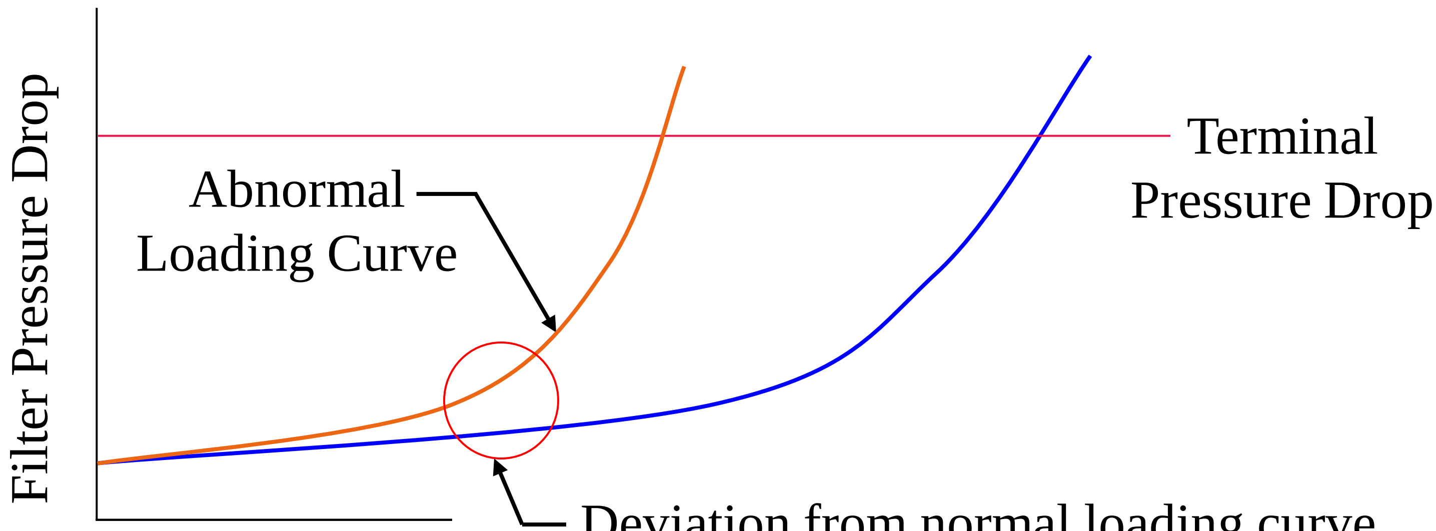
Single Pass of Fluid Through The System



Sum of Filter Element Loadings Over Time

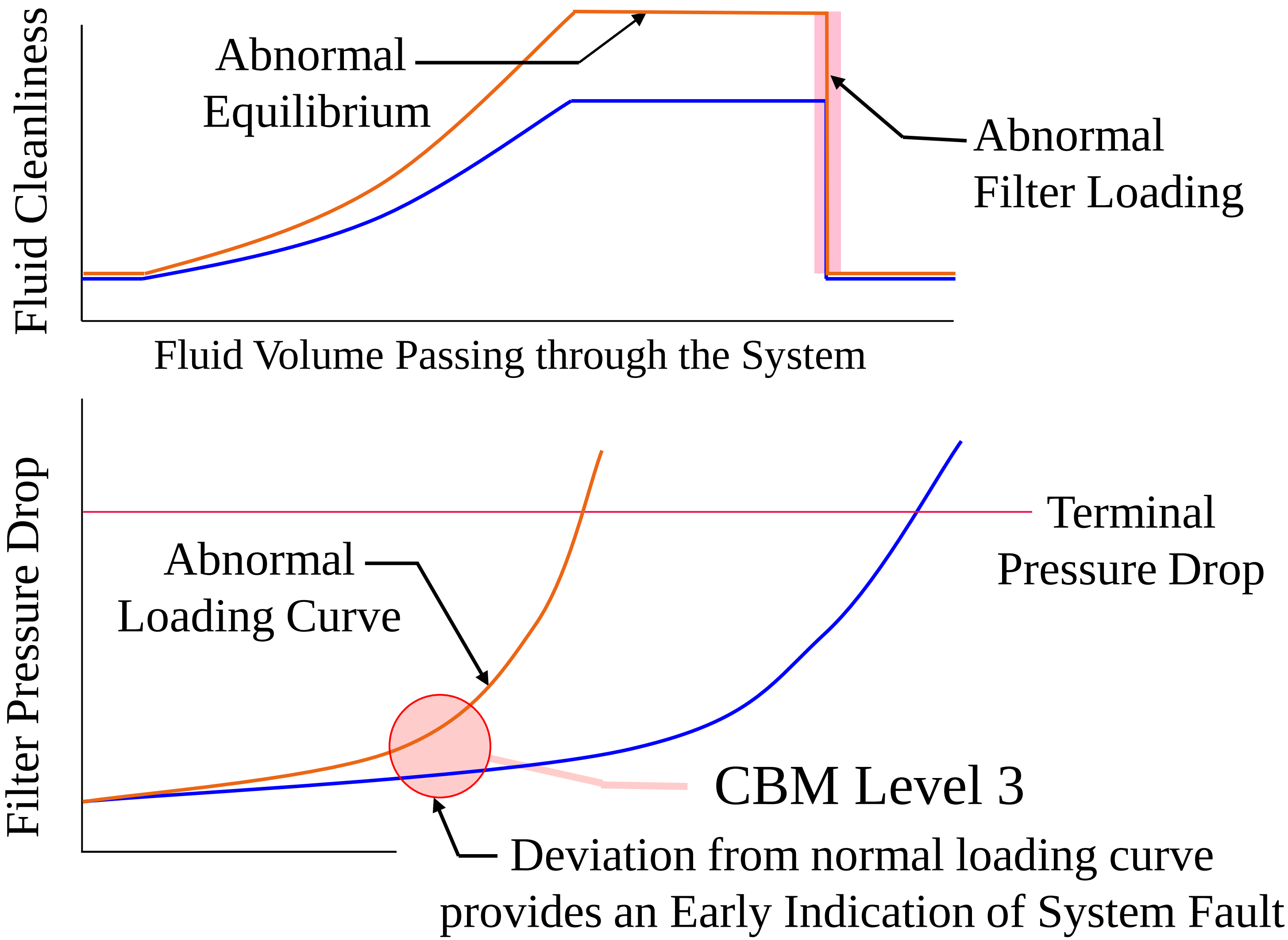


Deviation from normal loading curve provides an Early Indication of System Fault

Filter Monitoring Supports CBM

Single Pass of Fluid Through The System

Sum of Filter Element Loadings Over Time



Filter Monitoring Supports CBM

Comparison of Differential Pressure Monitors

Monitor Capability	Indicator	Switch	Indicator/Switch	Sensor
Port Mounting Compatible	yes	yes	yes	yes
Validate Operation	no	yes[1]	no	yes
Continuous output	no	no	no	yes
Remaining Life	no	no	no	yes
Mission Availability	no	no	no	yes
Schedule Service	no	no	no	yes
Service Filter Element	yes[2]	yes[3]	yes[2]	yes
Early Fault Indication	no	no	no	yes
Missing Filter Element	no	no	no	yes
System In Bypass	no	no	no	yes

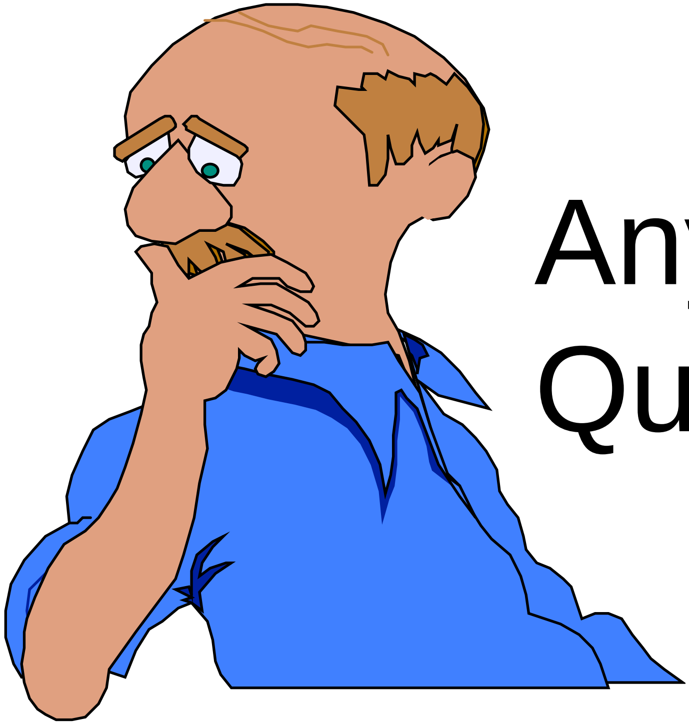
1 Only on systems having high pressure drop during cold start without thermal lockout
2 No validation, Poor operational reliability, Possibly system fault
3 Possible validation, Poor operational reliability, Possibly system fault

Filter Monitoring Supports CBM

Upgrading to a Differential Pressure Sensor to provide real-time in-system monitoring of the filter element's performance can support CBM in addition to providing:

- Improved indication tolerance
- No moving parts, robust design
- An integrated temperature sensor output
- Full utilization of the filter element
- Reduction of required filter changes
- Improved reliability and operational readiness

Filter Monitoring Supports CBM



Any Questions?

Challenges and Benefits of Applying ISO STEP

Stuart T. Booth

Systems Engineering Directorate

Office of the Director, Defense Research and Engineering

Charlie Stirk

PDES Inc.

Technical Advisory Committee Chairman

12th Annual NDIA Systems Engineering Conference

October 29, 2009

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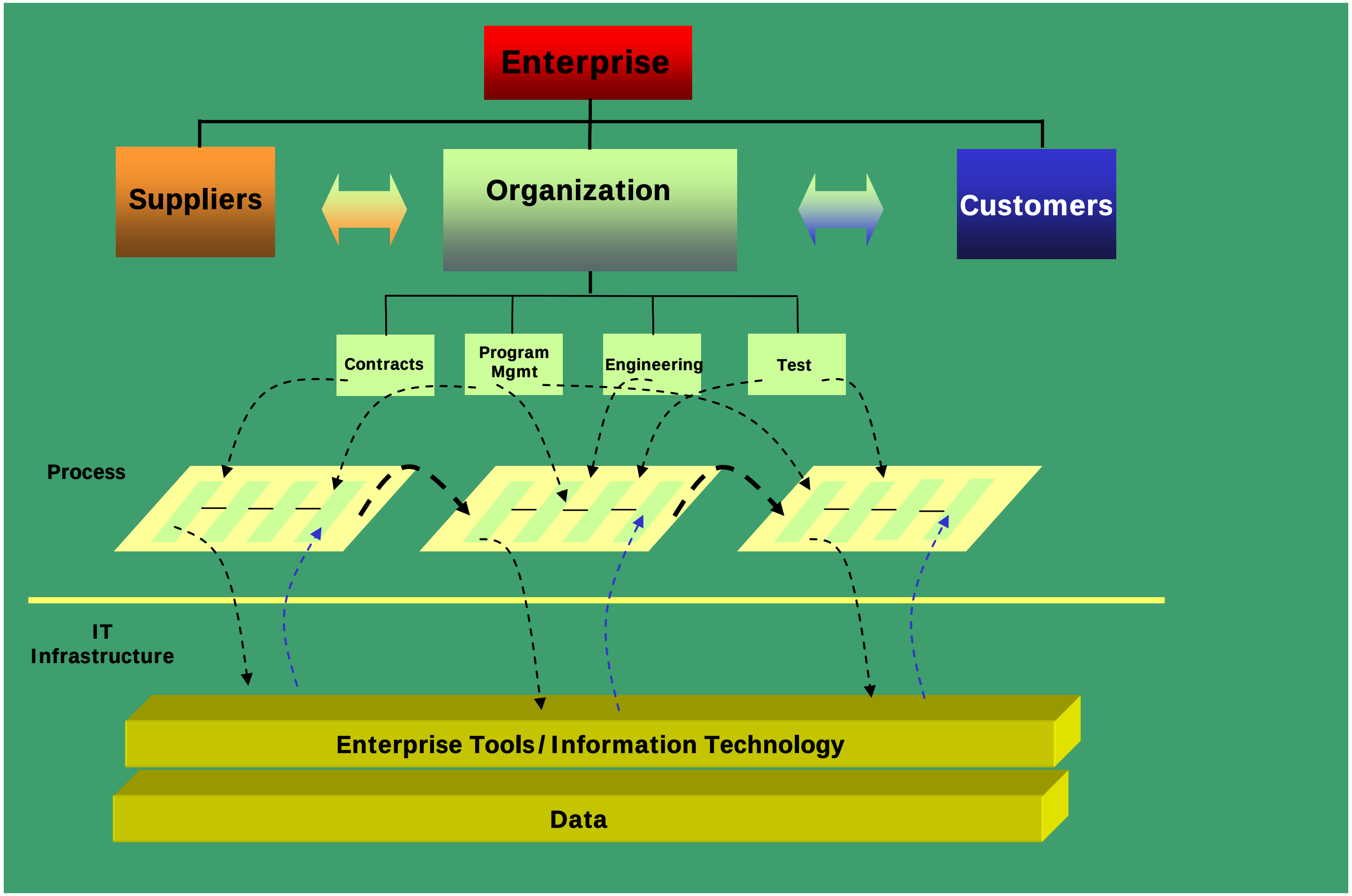
Outline

- **Overview of the Enterprise Challenge**
- **Tool Vendor and Data Management Challenges**
- **OSD Path forward on a Common Data Exchange Approach**
- **Overview of APs**
  - AP-233 and AP-239
  - Status of AP-233
- **AP Architecture**
- **AP Methodology for implementation**
- **Summary**

Notional Enterprise View "Synchronizing the Layers"



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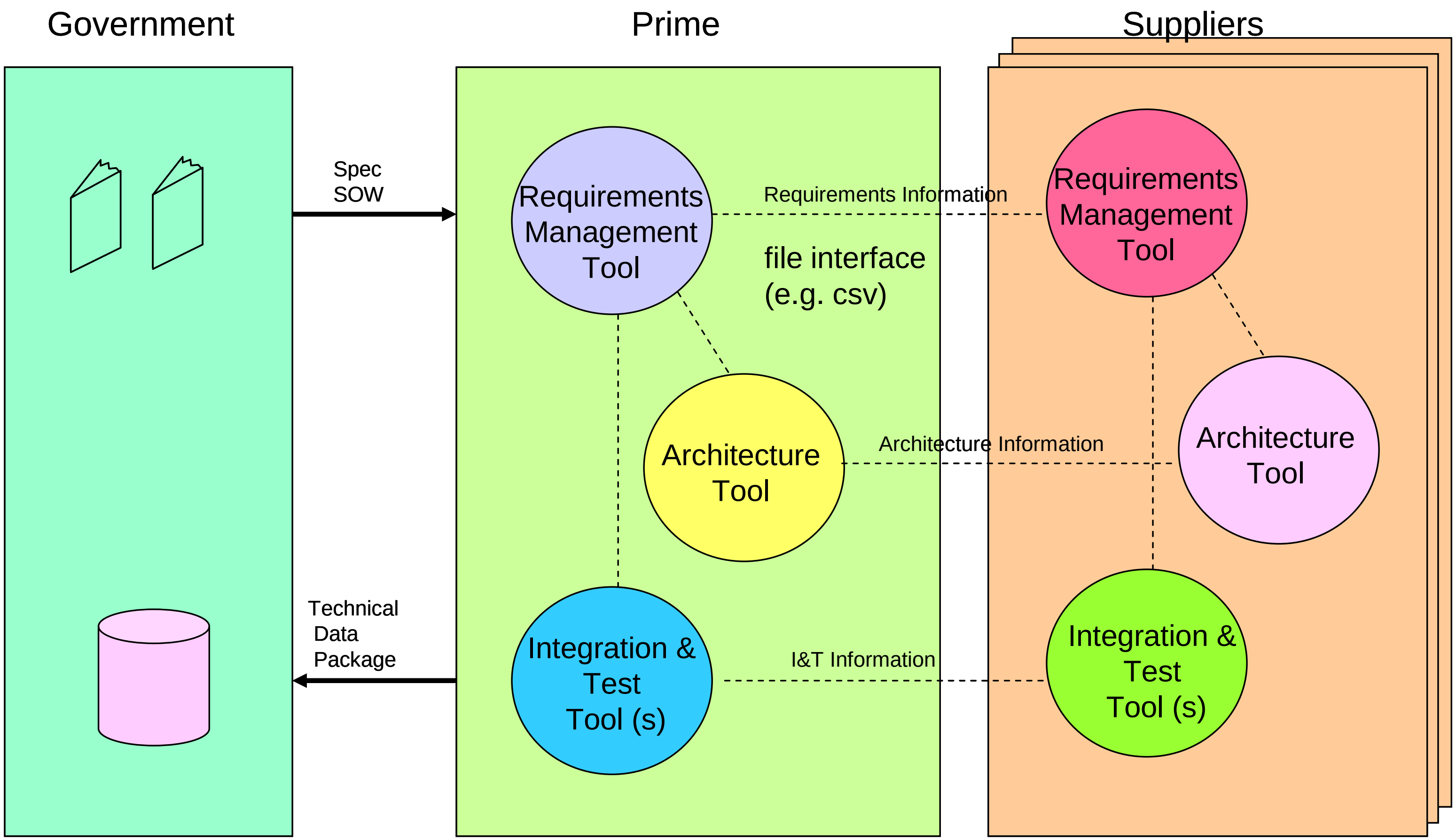
Tool Vendor and Data Management Challenges

- **Tool vendors are in competition resulting in no incentive to integrate tool capabilities…creating "islands of automation"**
  - Proprietary Data Interfaces
  - Proprietary Data Model
- **The tool customer must invest in tool integration to overcome the tool interface challenges**
  - Point to Point tool interfaces…custom scripts
- **Typical SE tools consist of:**
  - Requirements Management
  - Architecture
  - Integration and Test
  - Risk Management
- **All stakeholders suffer due to poor data integration and synchronization and consistency problems.**

Need another approach….
Common Data exchange protocol that facilitates data integration.

Notional Multi-Tool Vendor Typical Consequences



- Engineers must query multiple databases to get a full picture; painful process with temporary value
- Maintaining synchronization and consistency is nearly impossible
- Expert tool staff is needed to develop custom scripts to support point to point data exchanges

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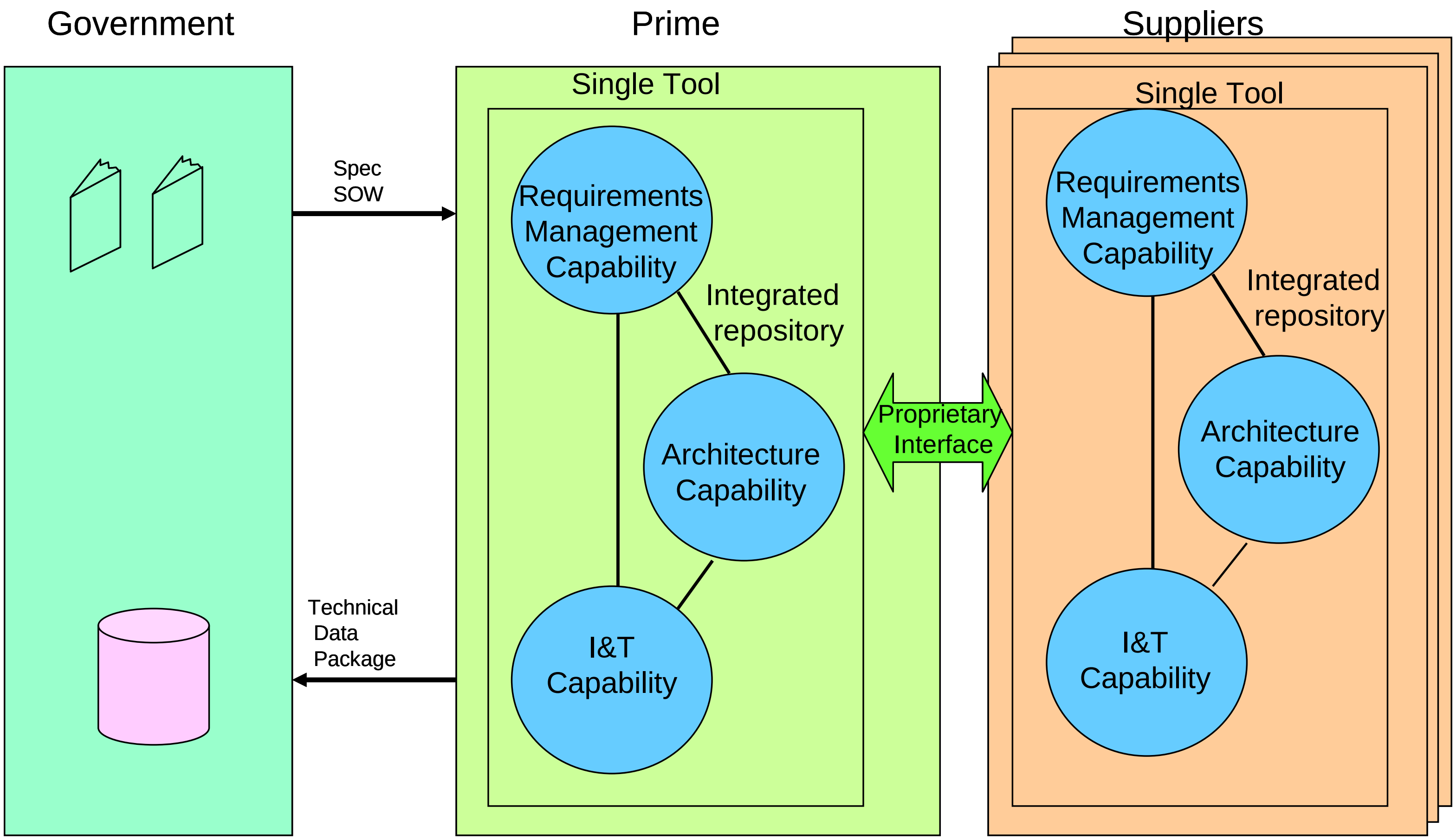
Notional Single Tool Vendor Typical Consequences



- Engineers can easily query data…data is synchronized and consistent
- Program is dependent on a single vendor
- Tools have proprietary interface and not easily integrated with other tools

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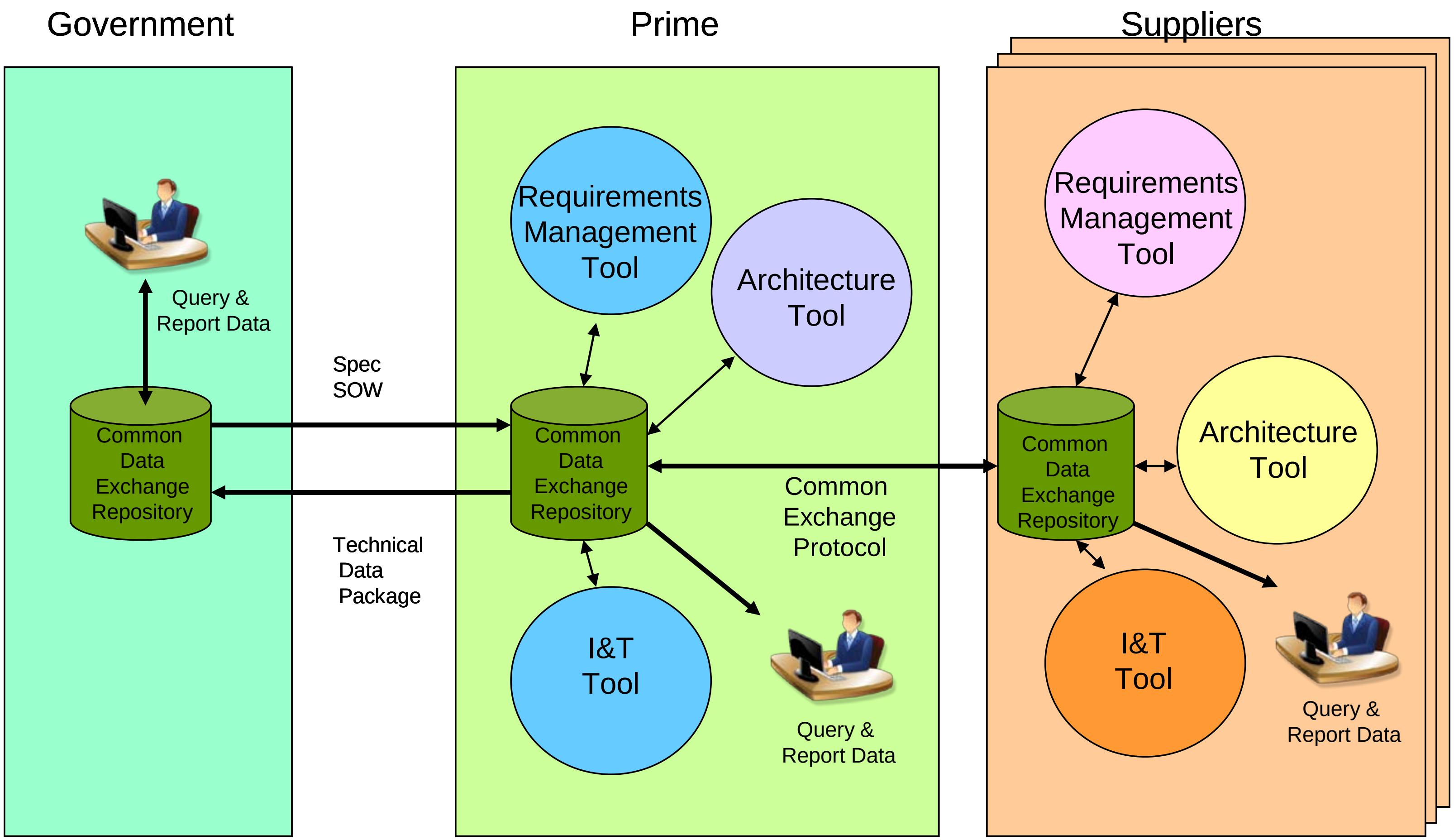
Notional Multi Tool Environment with Common Data Exchange and Repository



- Supports multi-tool environment….One size does not fit all
- Data Synchronization and consistency is achieved.
- Non proprietary data exchange interface facilitating ease of sharing data
- Engineers/Users can query and report data

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DoD Approach Going Forward

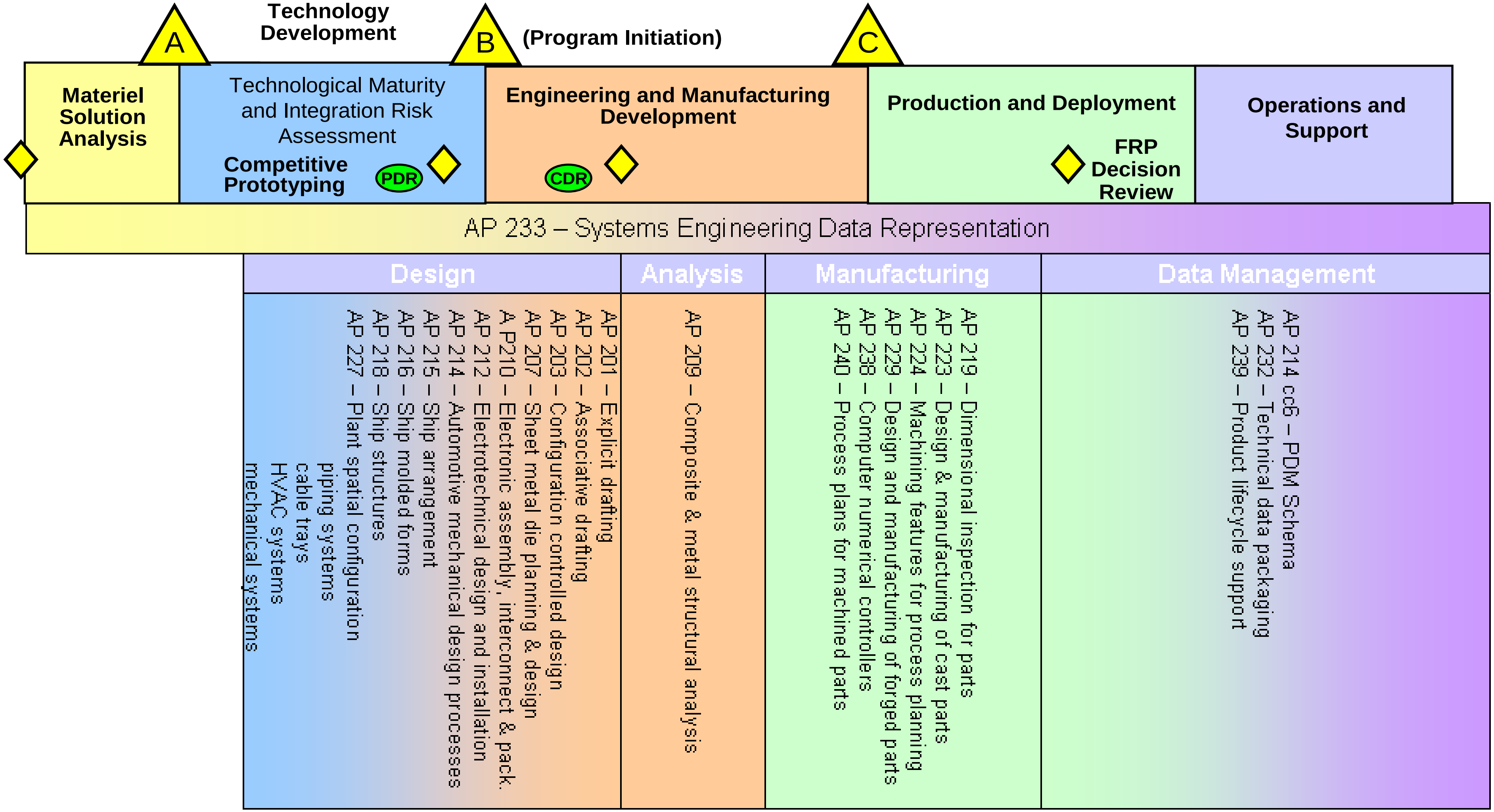
- **Investigating Common Data Exchange Approach**
  - ISO STEP AP-233 (For Systems Engineering)
- **This has its challenges**
  - Developing a robust data model to support systems engineering
  - Applying AP-233 in a commercial environment (flexibility and ease of implementation)
  - Getting the vendors to work with you
- **OSD Systems Engineering is funding a study through the Systems Engineering Research Council (SERC) to investigate the maturity of AP-233. This study will:**
  - Evaluate the current AP-233 (systems engineering) and AP-239 (for logistics) data models for compatibility.
  - Implement a working prototype of AP-233 with market leading systems engineering tools.
  - Adapt AP-233 to selected specialty systems engineering tools.
  - Adapt AP-233 to capture, maintain and export cost & schedule (EVM) data
  - Assess the ease of use and competencies needed to apply AP-233 for commercial application
  - Make recommendations on a path forward.

Industrial Data Standards

- **International Organization for Standardization (ISO) Subcommittee TC184/SC4**
  - Describe and manage industrial data through product life
  - 2007 ISO Eicher Leadership Award
    - For reusable information model building blocks to enforce interoperability and simplify implementation

      (Past winners include MPEG & ISO 9000)
- **Areas from product design, analysis & manufacture**
  - STEP – Standard for the exchange of product data
  - MANDATE – Industrial manufacturing management data
  - PSL – Process specification language
  - PLIB – Parts library
  - Process Plants including Oil and Gas facilities lifecycle data
  - eOTD – electronic open technical dictionary for catalogs

STEP for DoD Acquisition Cycle



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Mandates for ISO 10303 STEP

- requirement for Computer-Aided Engineering, Design and Manufacturing systems used by NASA to have interchange tools that support ISO 10303
  - NASA-STD-2817 Chief Information Officer (1999)
- "procure all product/technical data in attachment (1) digital formats and ensure product model data meets ISO/STEP requirements specified in attachment (1)."
  - ASN RDA Memo by John Young, Oct. 23, 2004, STEP for 2-D and 3-D CAD
- "implement a similar approach that adopts ISO 10303 to enhance interoperability" as described in Young memo above
  - OSD ATL Memo by Ken Krieg, June 21, 2005, STEP for UID
- "Ratifying nations agree to apply ISO 10303-239 for product data management in cooperative NATO acquisition programs."
  - NATO STANAG 4661, ratified by US
- "The PM shall require the use of International Standards Organization (ISO) 10303, Standard for Exchange of Product (STEP) Model Data, AP239, Product Life Cycle Support, for engineering data "
  - AFI 63-101 , April 17, 2009, PLCS for engineering data

Modular STEP AP's

- **Application Protocol (AP) Modularization Benefits**
  - Faster revision process (months rather than years)
  - Interoperability of implementations thru reuse
- **Modular AP Domains**
  - AP203 Mechanical CAD (parts & assemblies)
  - AP209 CAE (FEA and CFD)
  - AP210 EDA (aka ECAD, components to racks)
  - AP233 Systems Engineering
  - AP239 Product Life Cycle Support (PLCS)

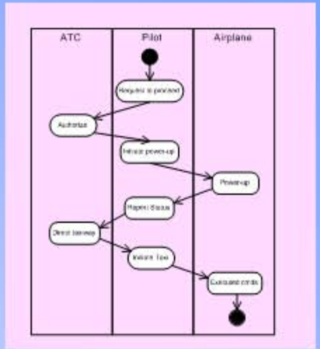
AP233 is One Enabler of INCOSE 2020 Vision

Model based systems engineering (MBSE)

Past

Future

- **Specifications**
- **Interface requirements**
- **System design**
- **Analysis & Trade-off**
- **Test plans**



– MBSE is the formalized application of modeling to support system requirements, design, analysis, verification and validation beginning in the conceptual design phase, and continuing throughout development and later life cycle phases.

INCOSE
International Council on Systems Engineering

SE Practice Transitioning from Document centric to Model centric

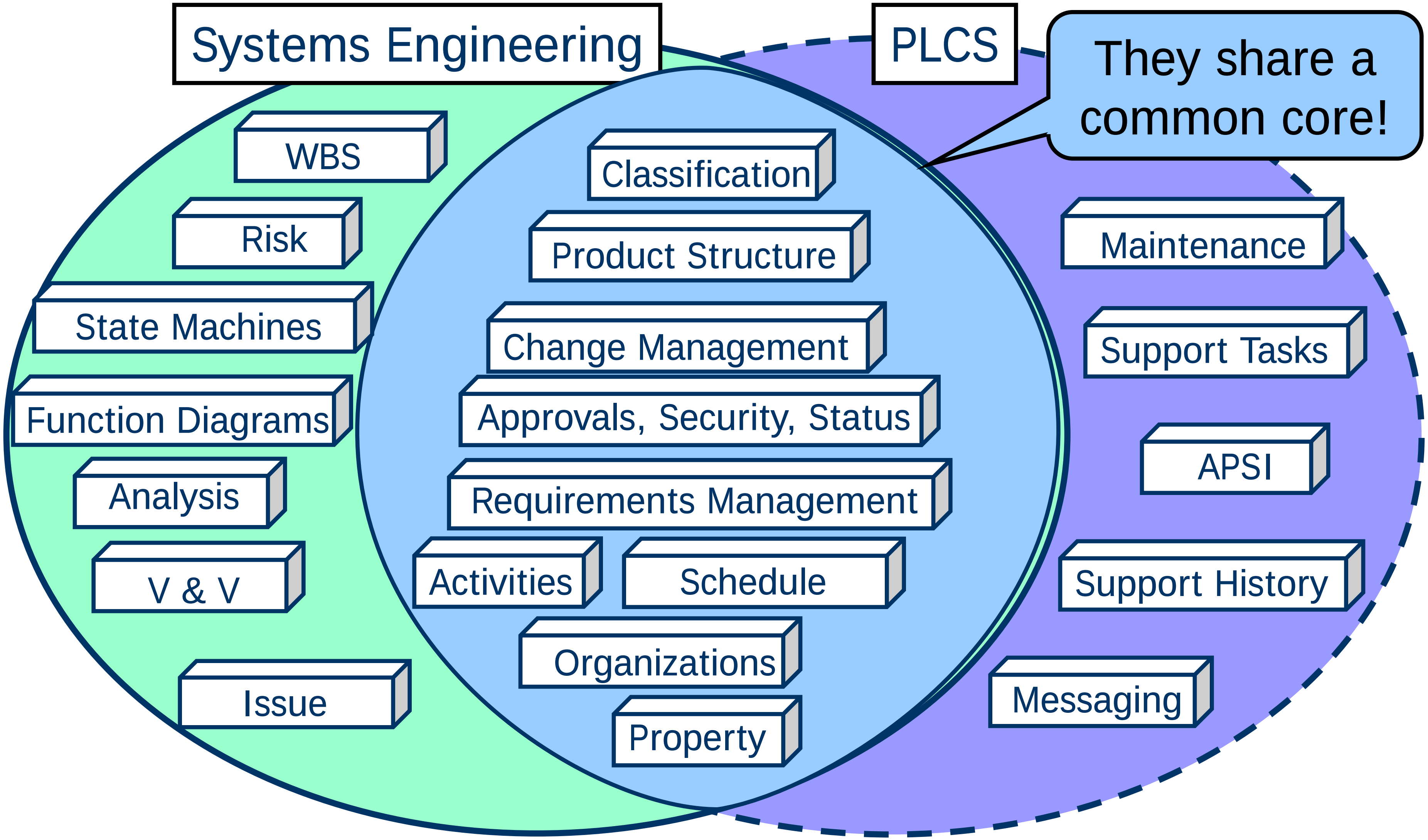
SE and PLCS

- **PLCS shares over 80% of models with AP233 SE**
- **Implementations of PLCS**
  - Pilots at NAVAIR, NAVSEA & Electric Boat
  - Production use at US Army TARDEC & contractors
  - US Army LOGSA developing PLCS DEX's
  - Extensive use by NATO allies for ships, aircraft, land vehicles
- **PLCS Edition 2 in ISO standardization process**
  - Fixes issues found in implementations
    - Incorporated into 233 through common modules
  - Incorporates new capabilities from AP233 SE
    - Risk, Decision Support, V&V

What Does AP233 Enable?

- **Program management**
  - Issue
    - Activities
    - Approvals
  - Risk
    - Probability & Consequence
    - Source & Impact
    - Contingency plans
  - Project
    - Organizational structure
    - Project breakdown
    - Schedule
    - Work structure
    - Management information resources
- **System modeling**
  - Decision support
    - Requirements management
    - Measures of effectiveness
    - Analysis interface
    - Verification & Analysis
    - Justification
  - System structure
    - Product data management
    - Breakdown
    - Interface
  - System behavior
    - Function based behavior
    - State based behavior

SE/PLCS Overlap



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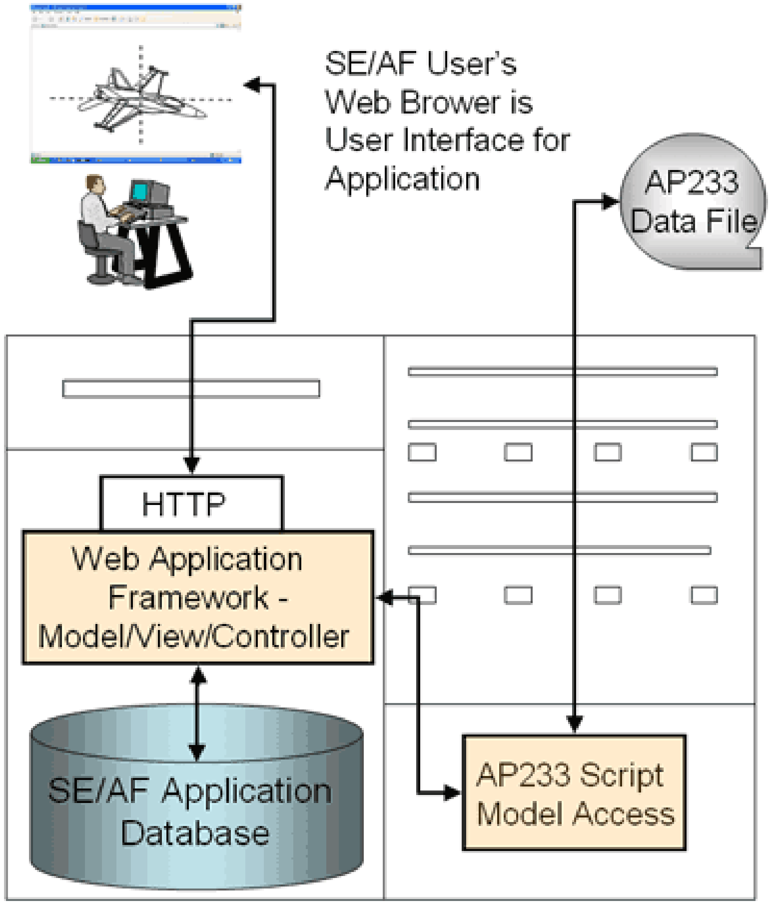
AP233 Implementations

- **Migration between versions of SE tools**
  - UGS Slate to UGS Systems Engineering
- **Exchange between Requirements Management tools**
  - IBM Requisite Pro and Telelogic DOORS
- **Model management of SysML and interoperability with other domains**
  - i.e. Risk, Program/Project, downstream CAD/CAM, PLCS
- **DoDAF to AP233 for exchange and archive**
  - CADM representation of DoDAF views
- **Multi-domain simulation management**
  - Requirements through analysis – EU Vivace & MBEST
- **Earned Value Management XML Schema mapping into 233 reference data**
  - Associate cost & schedule with systems engineering

.. And remember PLCS implementations are AP233 implementations where they overlap

Scripting API Implemented

- Application Programming Interface (API) in simple and accessible language
- Programmer must know concepts, attributes and relationships in AP233
- Ruby API code generated from AP233 EXPRESS ARM
- Available as open source from www.exff.org



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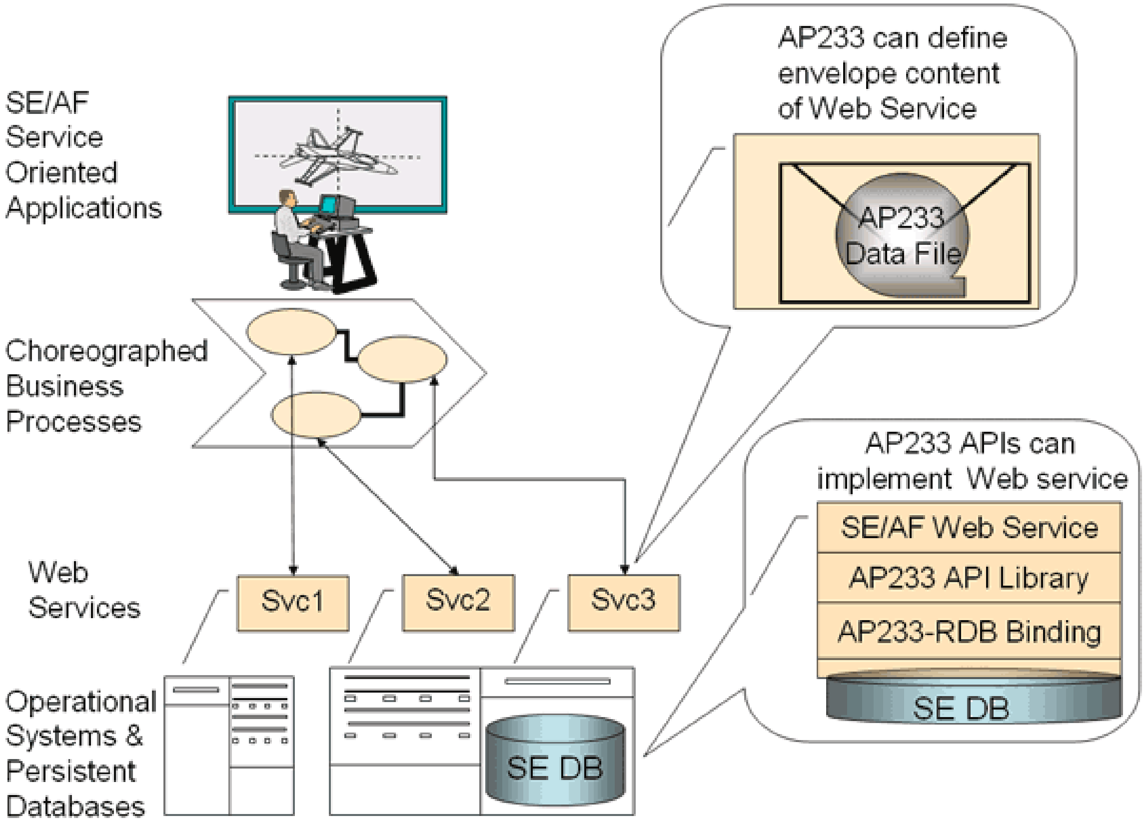
Proposed High Level API

- **Efficient Access: classes group objects that are create or destroyed simultaneously**
- **Business Objects: at level of SE domain concepts for mapping to software tools**
- **Web Services: functions of SE domain separate from data structures for integration**



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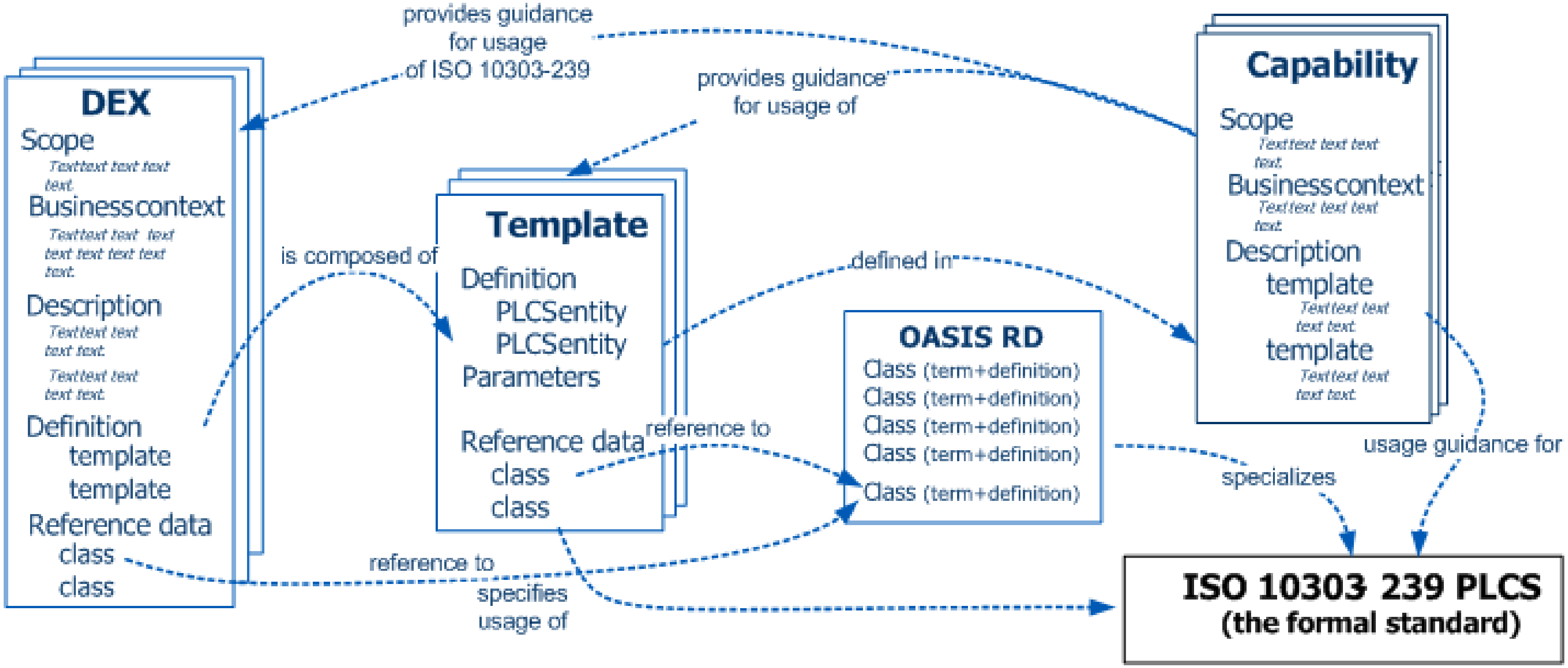
Extending 233/239 with Domain Semantics



- **Reference data in Web Ontology Language (OWL) tailors to domain**
- **Templates are assembled into Data EXchange Specification (DEX)**

Reference Data Issues

- **Need expert knowledge of STEP information models to properly subtype with reference data**
- **Many potential sources of reference data from different domains (need domain experts involved)**
- **Basic set theory used to classify reference data**
- **Potential for other uses of OWL (e.g., semantic web, reasoning)**

DoDAF and AP233

- **There exists a CADM-AP233 OWL representation (www.exff.org)**
  - Used AP233 WD2 version with fixes, CADM 1.02
  - Need to update to current version of AP233 and newer versions of CADM (1.5)
  - For legacy program analysis and data migration
- **Need to map UPDM with AP233**
  - SysML portions from NIST FutureSTEP project
  - Need to map UPDM extensions to SysML

SysML Issues

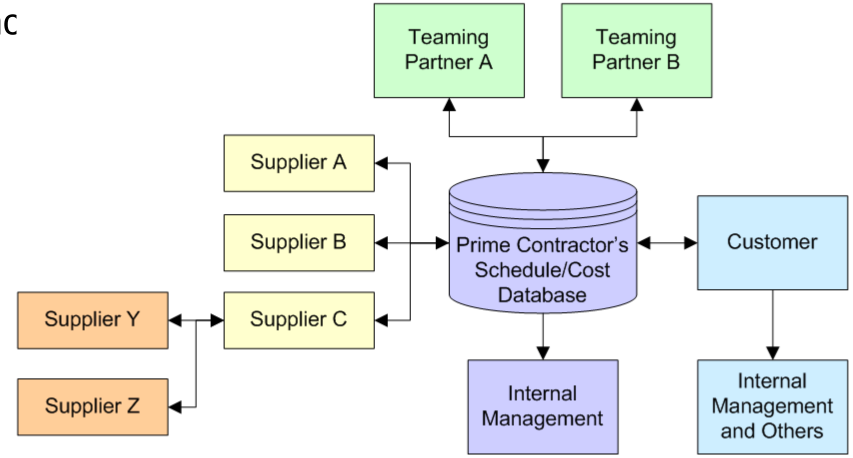
- **XMI – XML Metadata Interchange**
  - For UML and others expressed in OMG Meta Object Facility (MOF)
  - Vendor implementations currently incompatible
  - OMG Model Interchange Working Group to improve interoperability
  - Expect will be solved and XMI will serve for most inter-SysML tool exchange
- **Model configuration and other management aspects out of scope for SysML, but provided by AP233**

SysML and AP233

- **SysML to AP233 mapping underway**
  - Both based on INCOSE concept model
  - Creating reference data for SysML
  - Consensus is SysML info a subset/subtype of AP233
- **233 enhances SysML by**
  - Management and representation of
    - Risk, Analysis, Fine-Grained Configuration, Program/Project …
  - Linking to downstream CAD, CAE, CAM, PLCS
- **EXPRESS meta-model now in MOF**
  - 233 first test case of bringing STEP AP into OMG MDA

Earned Value Management

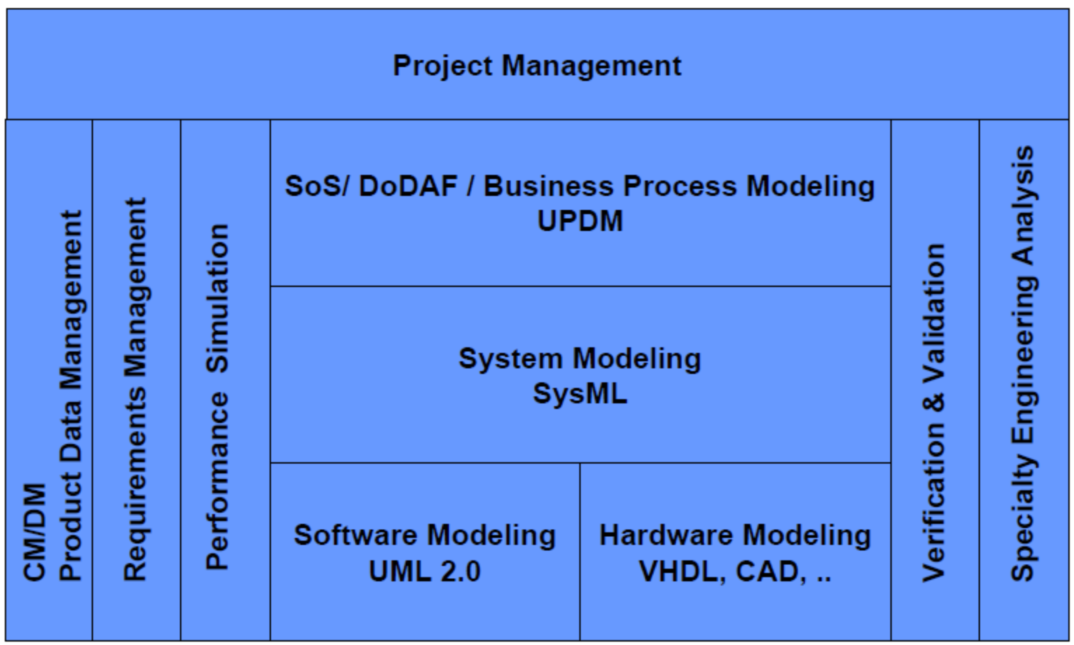
- **Government contract cost and schedule performance reporting**
- **Standards for EVM Systems**
  - ANSI/EIA-748-A EVMS Guidelines
  - XML Schema based on ANSI X.12 806 & 839
    - NDIA Program Management Systems Committee XML Working Group
    - Defense Contract Management Agenc



- **EVM Central Repository**
  - Required for major programs
  - Used for analysis
  - PM software vendors support
- **Mapping EVM into 233**
  - OWL Reference Data
- **Need to map EVM Schema and 233-based Schema**
  - Maintains upward compatibility

233 Pulls it All Together

- **STEP AP233 can integrate cost, schedule and systems engineering**
- **Models can be managed, inter-related, and linked to specialty engineering domains**



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AP233 is designed to

- Capture system requirements, design and analysis data over the life cycle
- Support interoperability and integration of Systems Engineering tools
- Provide a “front end” to PLCS-based Support Engineering tools
- Link with detailed design, PDM, analysis, etc. tools through other STEP protocols
- Align with OMG SysML and UPDM for DoDAF
- Enable INCOSE’s vision of Model-Based Systems Engineering

For Additional Information

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Dynamic Modeling of Programmatic and Systematic Interdependence for System of Systems Acquisition

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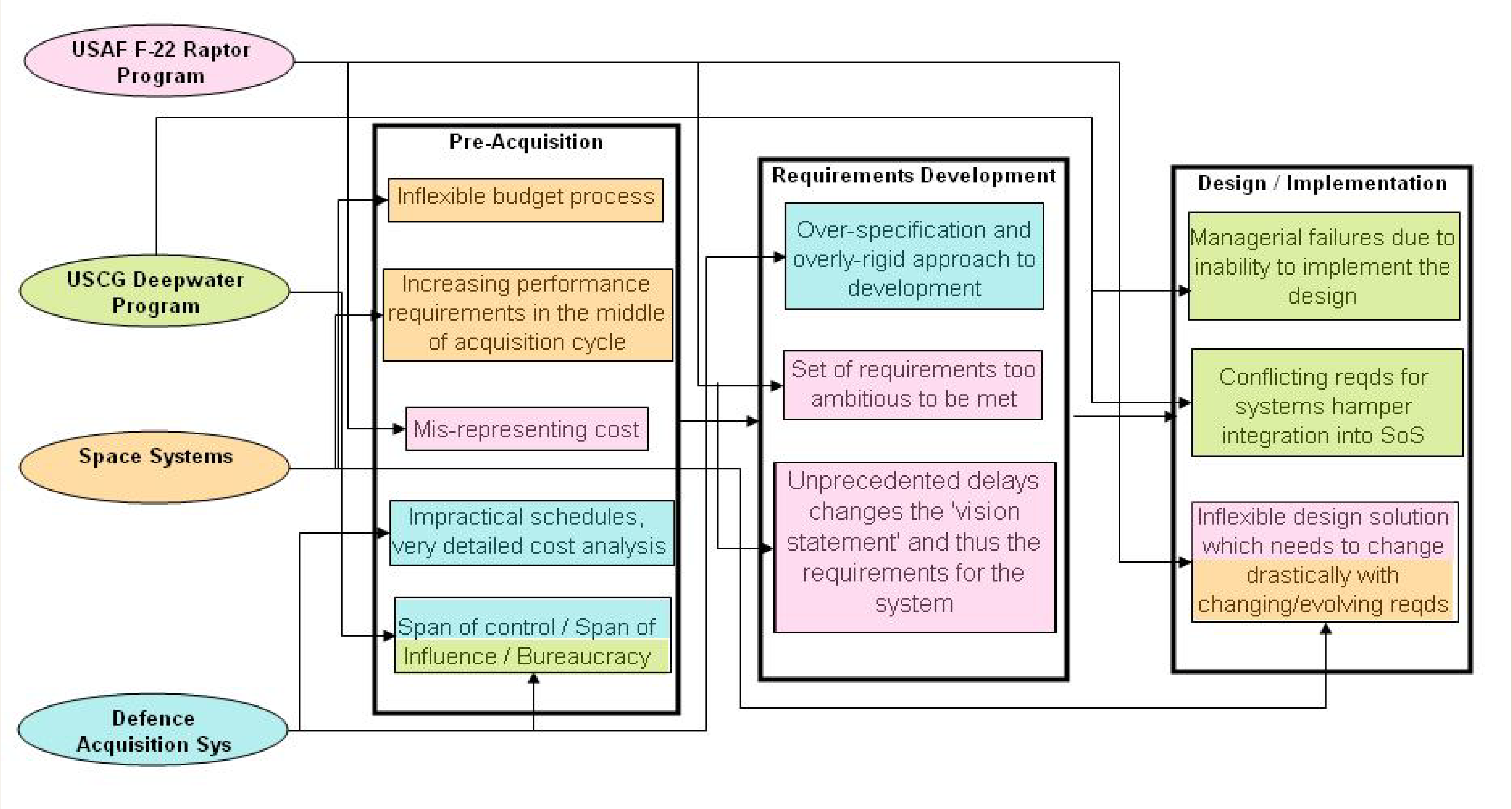
Overview of Agenda/Presentation

- Motivation and problem statement
- Recap from prior work
  - Conceptual model based on OSD's SoS SE Guide
  - Computer simulation: Exploratory SoS Acquisition Model
- Snapshots from illustrative problems
  - Dynamic impacts of risk
  - Implementation of system-specific risk
  - Impact of system-specific risk and SoS network topology
- Summary

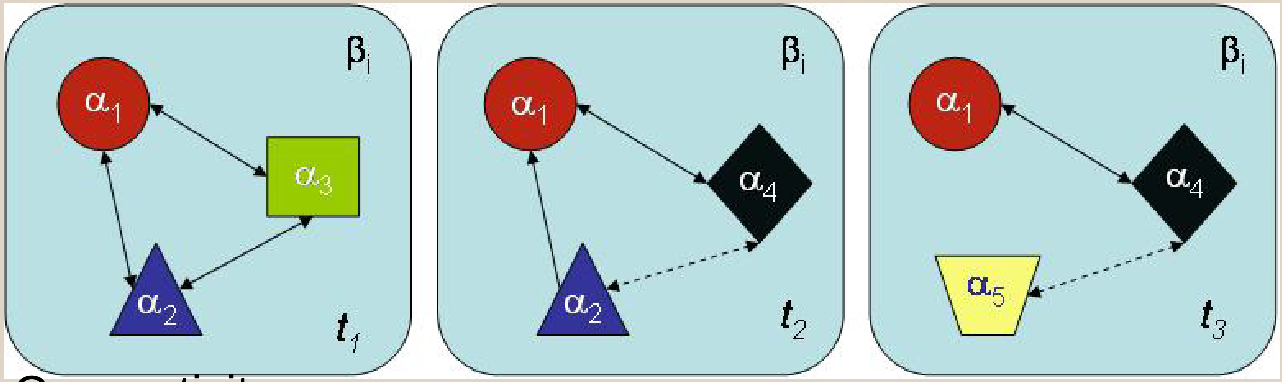
Motivation

Literature on recent history indicates a variety of challenges for SoS acquisition



SoS Sources of Complexity

Working Definition for Complexity:
the amount of information necessary to describe the regularities in a system effectively



- Dynamic and Uncertain Connectivity
  - **between** levels of abstraction
  - **across** scope dimensions
- "Porous" boundary
  - Changes in constitution of SoS
- Heterogeneity & Multiplicity
  - Multiplicity of perspectives: A root cause of interoperability issues
  - Heterogeneity of participants (within and between Human & Technical); Socio-Technical Systems

- multiple time scales
- emergence (unforeseen interdependencies)
- Evolving nature of an 'open system'

Root Causes of Failure
(within acquisition processes)

- *Misalignment* of objectives among the systems
- Limited *span of control* of the SoS engineer on the component systems of the SoS
- *Evolution* of the SoS
- *Inflexibility* of the component system designs
- *Emergent behavior* revealing hidden dependencies within systems
- *Perceived complexity* of systems
- Challenges in *system representation*

Used categories from Rouse, W. (2007, June). Complex Engineered, Organizational and Natural Systems. *Systems Engineering*, 10, 3., pp. 260-271

Recap: Research Goals

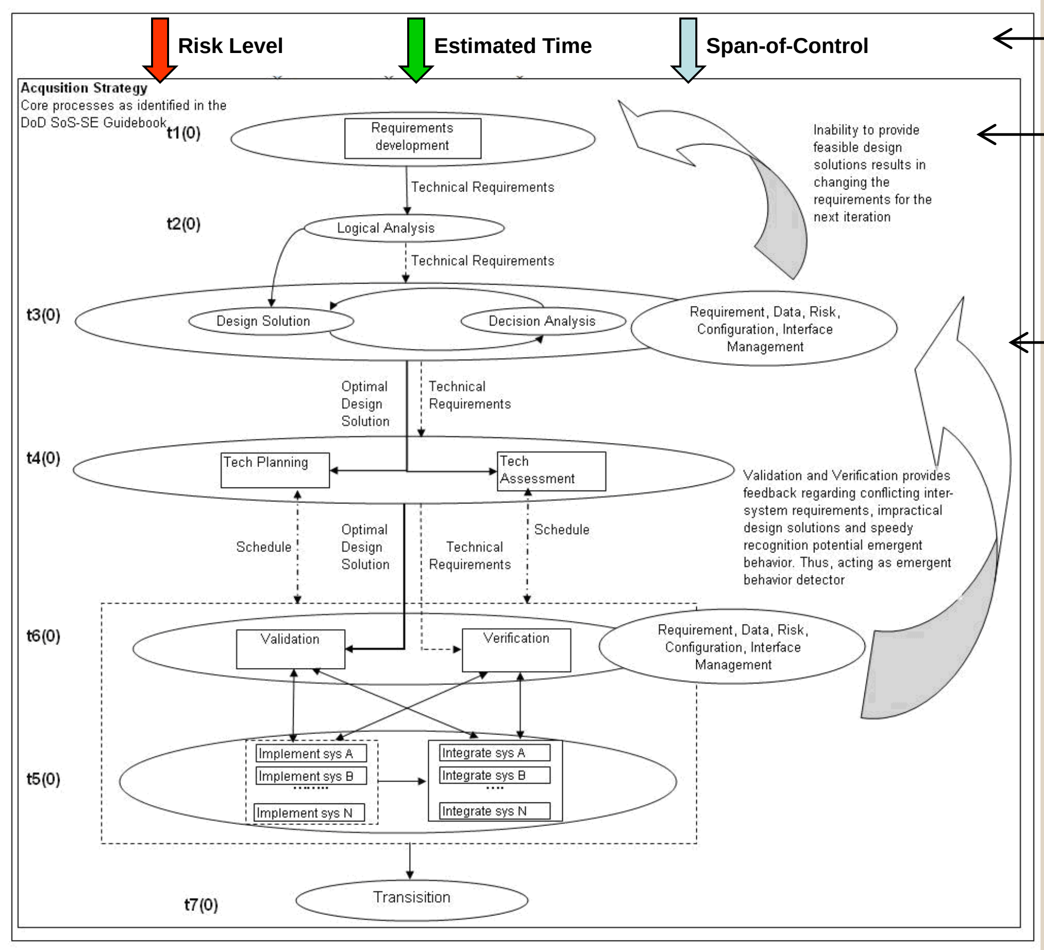
- Uncover underlying functions affected by complexities due to evolution in SoS acquisition and span-of-control
- Capture Dynamics: Exploratory SoS Acquisition Model
  - Depicts the processes (SoS SE Guide) in a hierarchical setting
  - Show the flow of control between the processes throughout the acquisition life-cycle
  - Interactive computational model: allow users to ‘explore’ complexities
- Experiment: Generate insights and approaches to improve the probability of program success
- Mapping of Operational Views (OV) to Systems Views (SV)
  - System capabilities and their interconnections

Recap: Development of a Dynamic, Exploratory Model for SoS Acquisition

1. *Pre-Acquisition Model (not included here)*
   – Understand the influence of external stakeholders on the acquisition process

2. *Acquisition Strategy Model*
   – Based on the 16 technical management and technical systems engineering processes outlined in the Defense Acquisition Guidebook (5000 series) applied to an SoS environment (SoS-SE Guide)
   – Conceptual model depicts the processes in a hierarchical setting to show the flow of control between the processes throughout the acquisition life-cycle

Recap: Acquisition / Development – The Paper Model (based on SoS SE Guide)



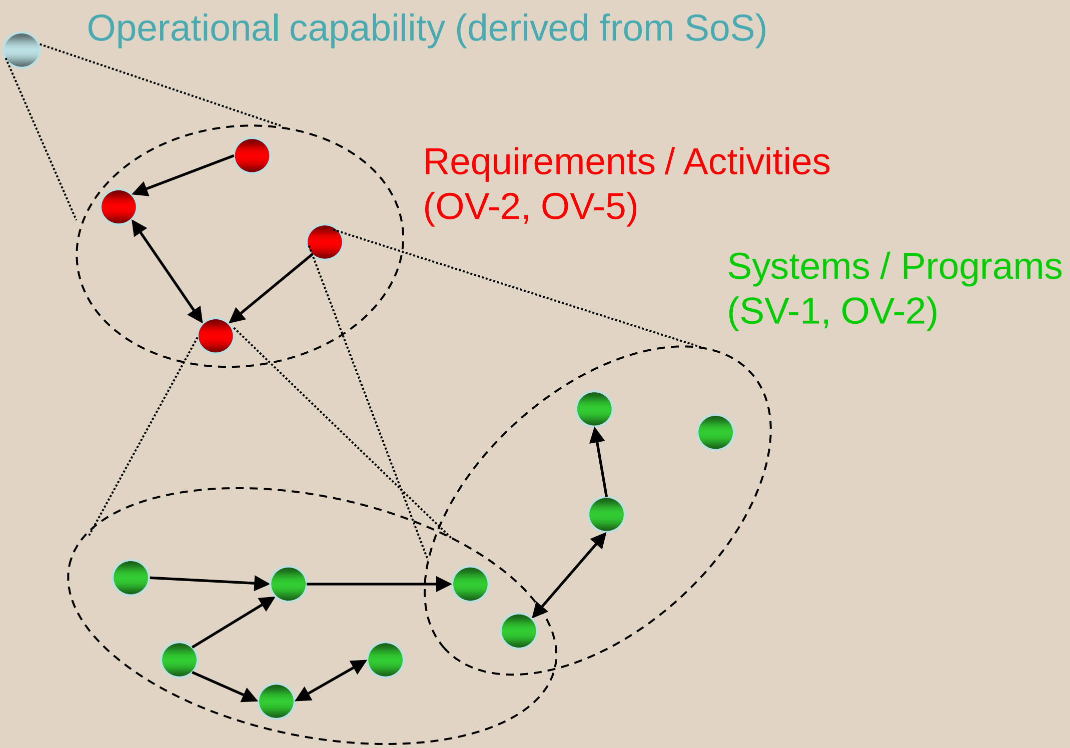
Project-level (SoS)
Risk profile: low, med, high
Span-of-control: low, high

Requirement-level
- Number of requirements
- Requirement dependency
- Probability of disruption

System-level
- System dependency
- Initial completeness level
- Int/Imp time
- Probability of disruption (comes from risk-profile)

Output
Completion time

Methodology Abstraction



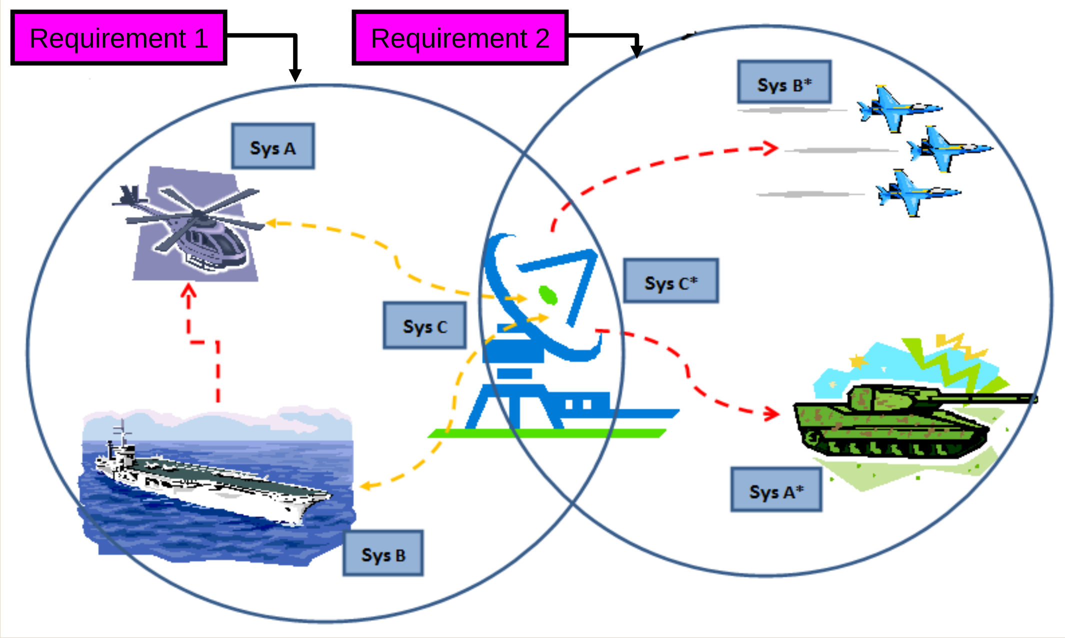
Operational (OV): systems work together to provide a capability

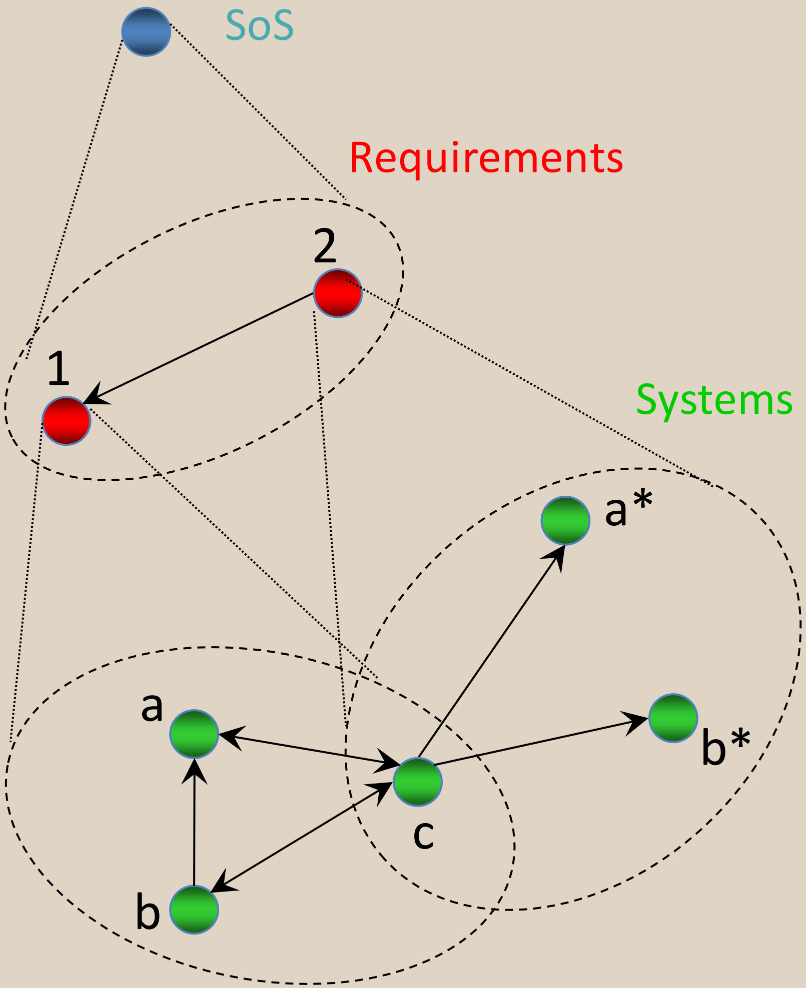
System (SV): define nature of interaction between systems

Programmatic: relationship between systems during development

- Discrete-event simulation with probabilistic behavior of systems
- Levels have predetermined probability of disruption
  - Requirement-level disruptions: affect design solutions (i.e. design solution of system X cannot meet requirement)
  - System-level disruptions: affects completeness level of system and completion time (i.e. set back in implementation phase of system X results in longer time)

Illustrative Example





System Dep (R1)

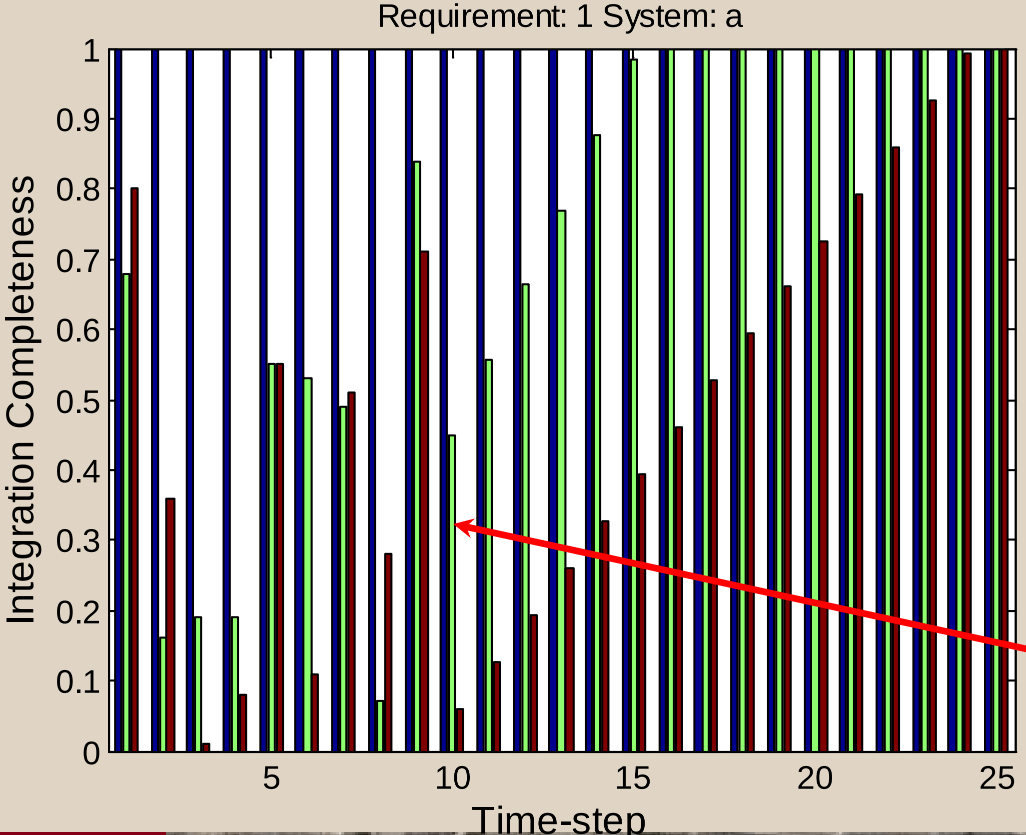
$$\begin{bmatrix} 0 & 1 & 1 \\ 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix}$$

System Dep (R2)

$$\begin{bmatrix} 0 & 0 & 1 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}$$

Effects of Disruptors (system-level)

- Inevitable disruptions on both system-level and requirement levels will occur
- *Technology Assessment* is able to immediately trace and resolve the problem
  - This prevents the development from stalling or regressing over multiple time-steps

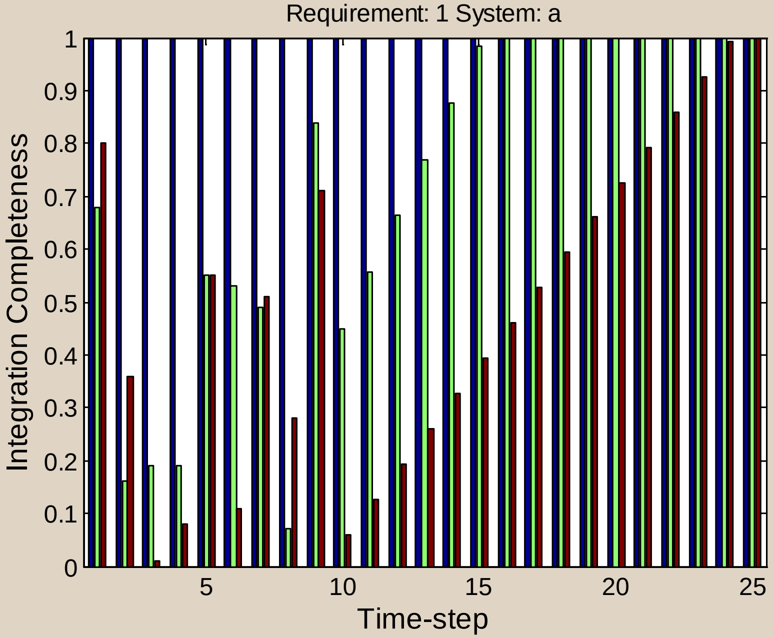


Each color represents an individual system (system 'a' is blue)

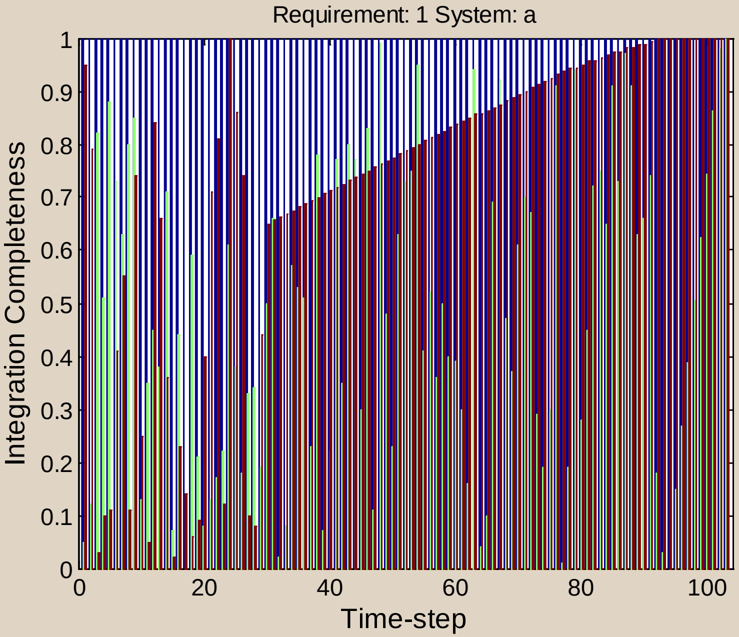
Negative disruptions correspond to system re-engineering and lower completeness level in Integration (and Implementation) phase

Effect of Project Risk

(determines probability of disruption in Integration and Implementation phase)



Low-risk instance



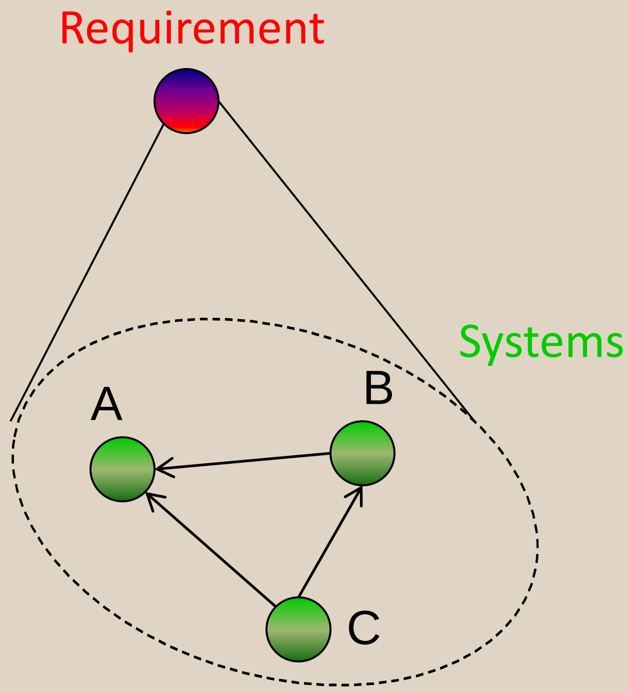
High-risk instance

- Some projects have a much higher risk factor
  - They are more vulnerable to negative disruptions in their development
- Higher risk of disruptions implies more time to complete stages
  - In fact, completion may fail → return to Design Solution
- Not all systems in a SoS, however have the same risk-level

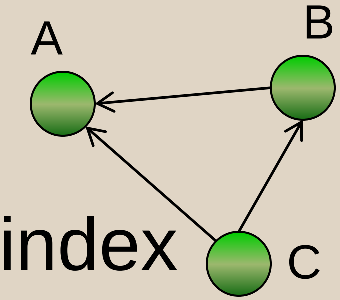
Impact of System-Specific Risk

- Quantify the impact that system-specific risk has on the completion time of the SoS
  - Measure risk in a SoS network
  - Observe changes in completion time due to different risk-levels

- Example problem
  - One requirement and three component systems
  - Each system can have a distinct risk-level
    - Risk-level indicates probability of disruption in implementation & integration phase
  - Risk for the SoS varies as the level and combinations of system-specific risk change
  - Wan to capture the effect of these changes and measure the risk for t he entire SoS



Network-Risk Metric



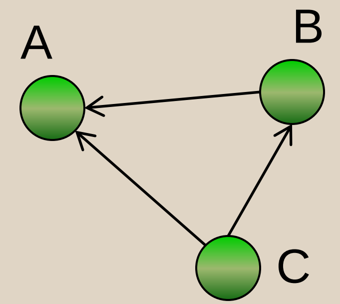
- Consider the following network-risk metric/index

$$R = \sum_{i=1}^{N} \sum_{j=1}^{N} r_j \cdot A_{i,j}$$

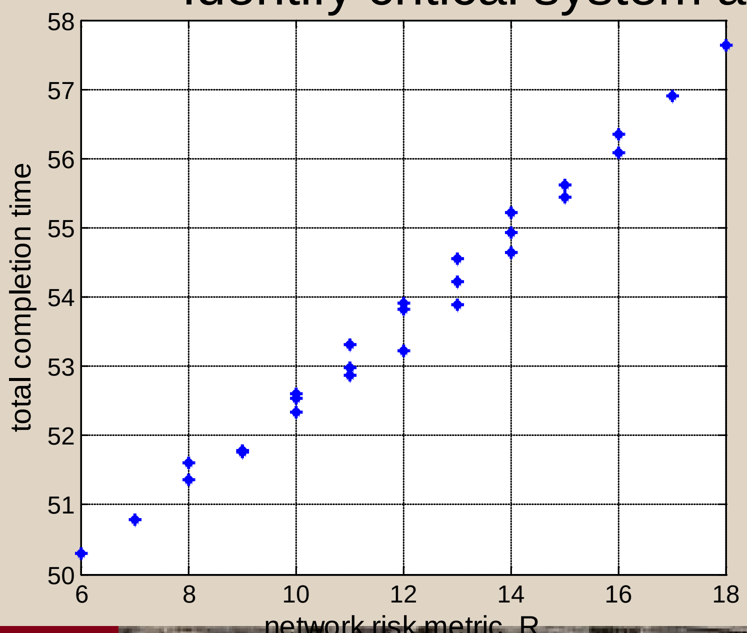
where r_j is the risk of system j and it has values of 1, 2, or 3 (for low, mid, and high risk) and A is the adjacency matrix (system interdependencies)

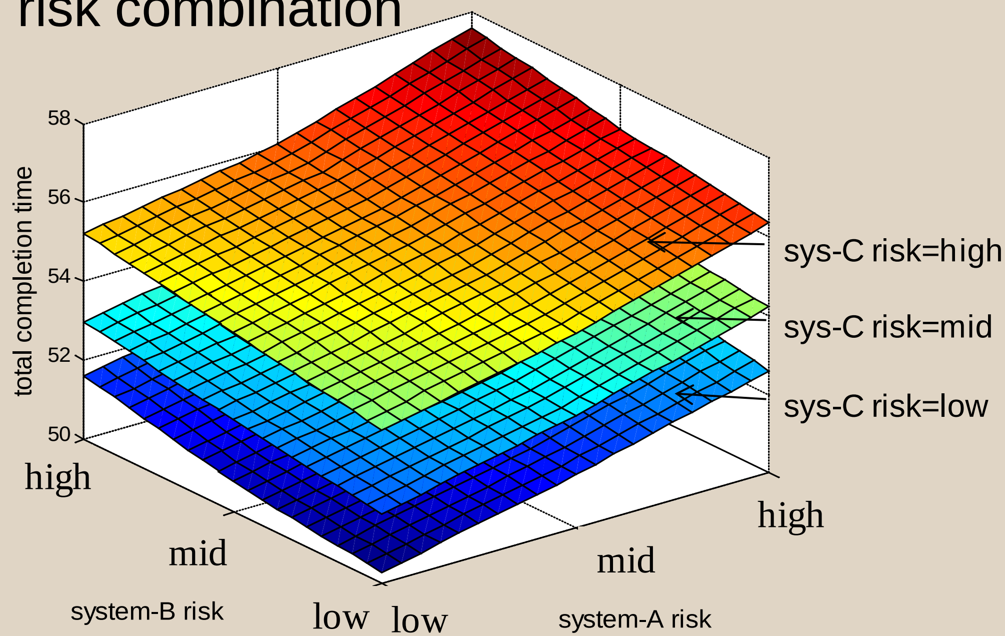
- The network-risk metric is a dimensionless number and considers the system-risk and the system dependencies simultaneously
- Current implementation does not yet consider the higher-order system interdependencies (cascading effects of risk)
  - i.e. system A is impacted by system B, but system B is also impacted by system C; risk of system A should be more than just the sum of the risk of system-A and system-B

Exploratory Model Experiments



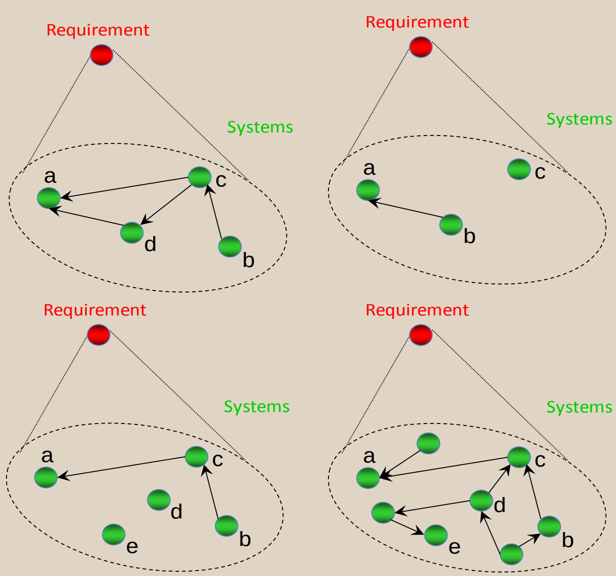
- Experiment set-up
  - Each system can have a low, mid, or high risk-level
    - A total of 27 combinations for the 3-system network
  - Run Monte Carlo simulation of Exploratory Model (500 samples)
- Experiment results
  - Capture impact of system-specific risk on SoS completion time
  - Identify critical system and risk combination

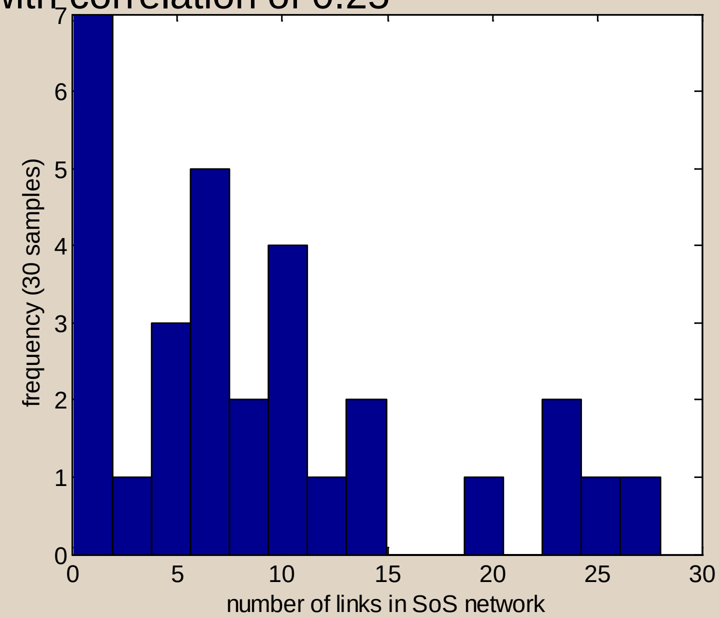




Impact of System-Risk and SoS Network Topology

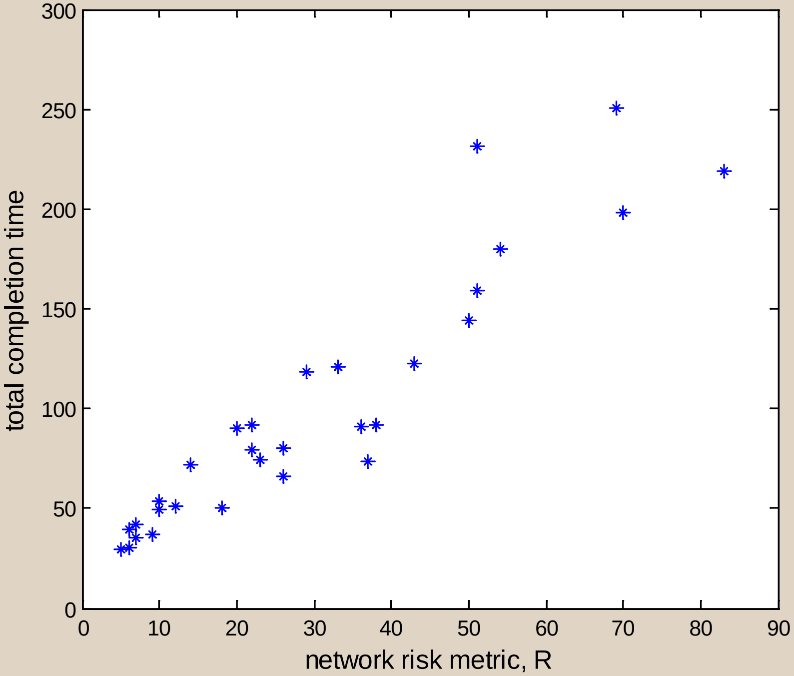
- Previous experiment captured the impact of system risk for a fixed SoS network
- It is also possible to consider the impact of system-specific risk coupled with different network topologies
- Consider 30 randomly generated SoS configurations
  - Uniformly random selection of number of systems (up to10 systems)
  - Random selection of links between systems with correlation of 0.25





Exploratory Model Experiments

- Experiment set-up
  - For each system in each SoS network randomly generate a risk-level
  - Run Monte Carlo simulation of Exploratory Model (500 samples) for each SoS network
- Experiment results
  - Capture impact of system-specific risk AND network topology (i.e. interdependencies) on SoS completion time
- Observations
  - SoS with higher risk metric/index have higher completion time
  - Scatter potentially due to the higher-order impact of risk (i.e. cascading effects)



Observations

- Exploratory model is intended to enable acquisition professionals and program engineers to learn about complexities, dynamics, and disruptions, identifying markers of failure and success
  - Evolution of interdependencies
  - Network structure and span-of-control of SoS
- Current implementation if system-risk seems to capture the right things
- System-specific risk and SoS network topology experiments are a means to compare different SoS options that may satisfy the same requirement
- Shortcomings
  - R does not capture the higher order impact of dependencies
  - Current efforts focused on addressing this

Thank You

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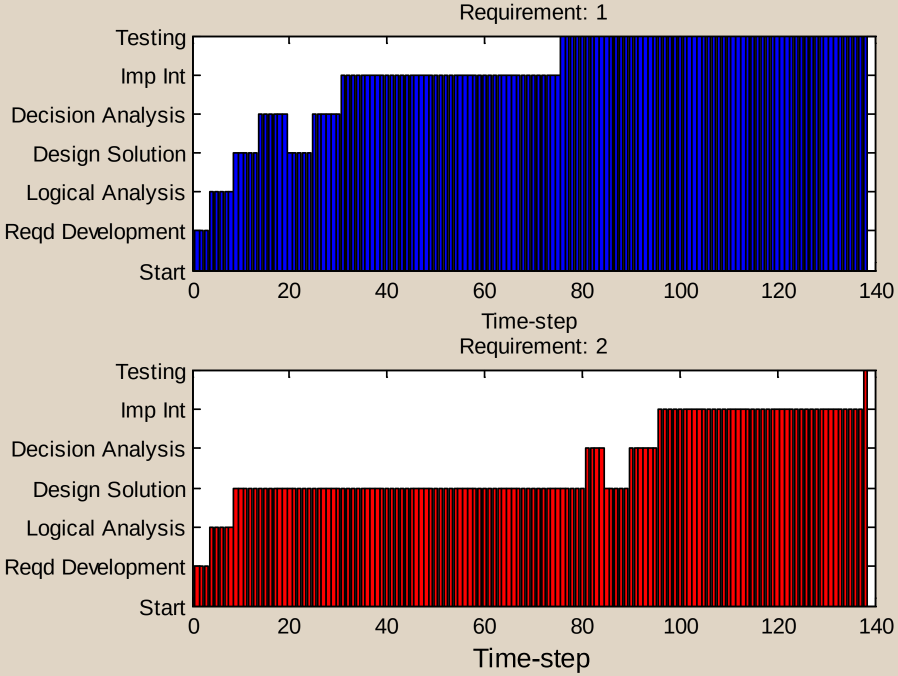
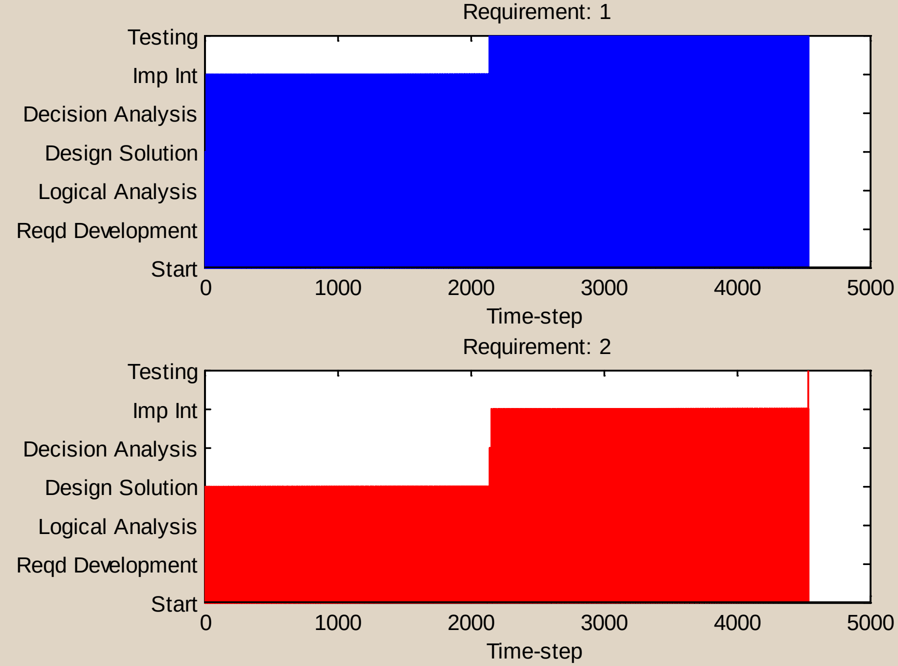
Effect of Span-of-Control



High Span-of-control



Low Span-of-control

- Span-of-control has large impact on project time
  - High span-of-control → SoS level authority, can implement in parallel
  - Low span-of-control → less coordination, implement in series, results in longer completion time

Raytheon
Customer Success Is Our Mission

Supportability Lessons Learned with Line Replaceable Modules

NDIA
System Engineering Division

Heity Hsiung

October 29, 2009

NDIA
National Defense Industrial Association

DoD Directions for Life-Cycle Support

Raytheon

- Reduce operating and support (O&S) costs for deployed weapon systems
- Minimize the logistics footprint for deployed weapon systems

NDIA
National Defense Industrial Association

One Way to Get There

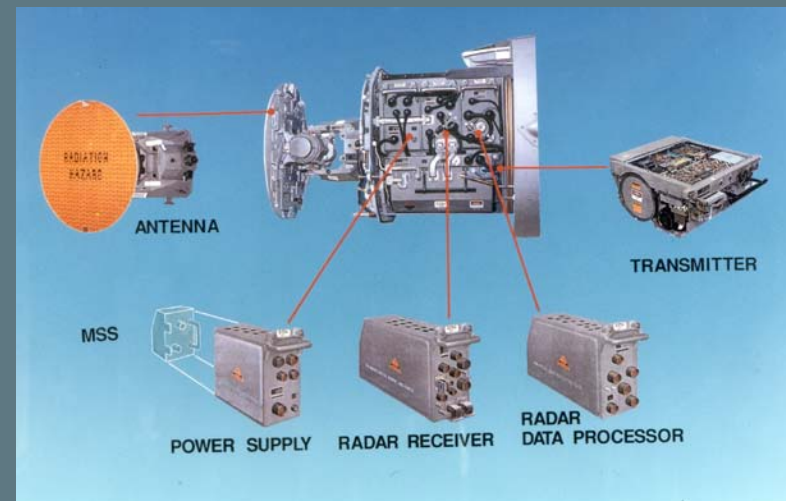
- Design into our weapon systems lower value Line Replaceable Units (LRUs)
- Line Replaceable Modules (LRM) is one solution
- I will discuss some considerations/issues of implementing LRMs

LRM vs. LRU

Raytheon

Line Replaceable Module

Line Replaceable Unit



LRM is more cost effective, light weight and easier to remove/replace

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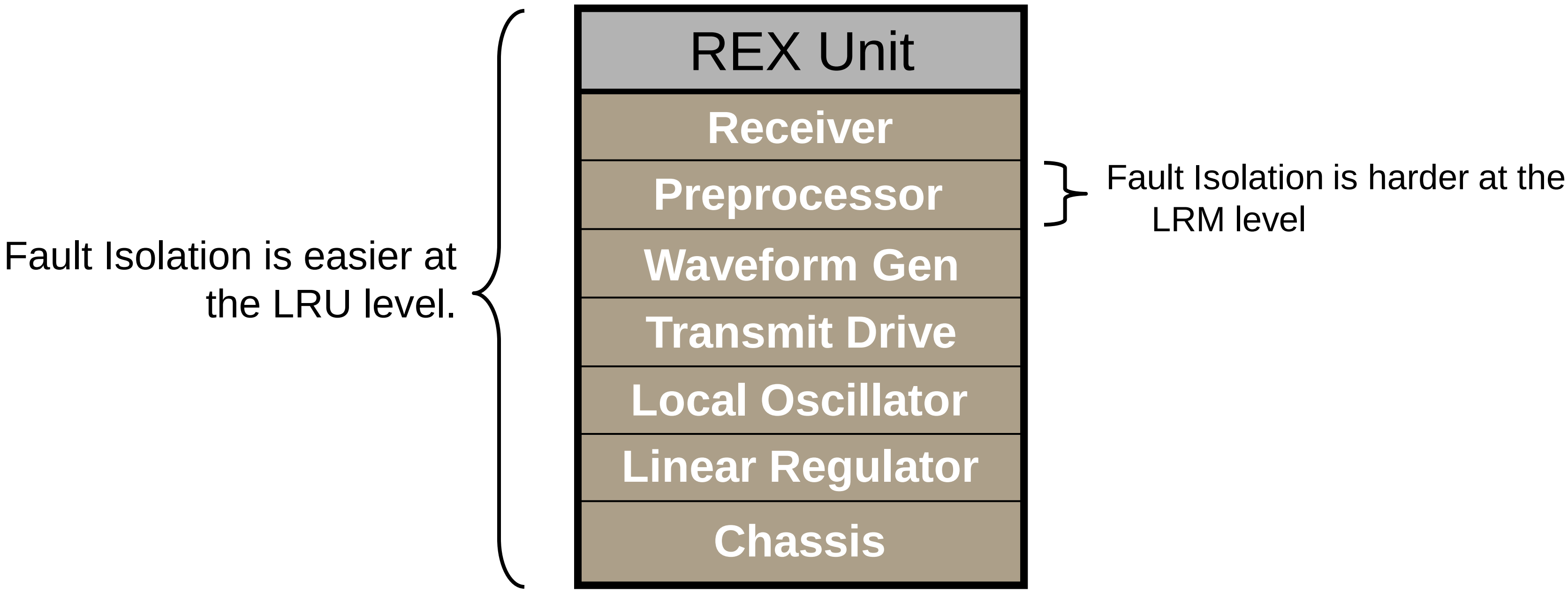
Environmental Design Considerations

- Vibration
  - – Shock mounting approach
- Temperature
  - – Operating temperature requirements
  - – Not-in-use requirement (non-mission use)
- ESD
  - – Prevent ESD damage due to any environmental factors

BIT Design Considerations

- Fault detection vs. fault isolation
  – Harder to isolate to LRM



BIT Maturity: higher development costs → lower support costs

National Defense Industrial Association

Maintainability Design Considerations

- Accessibility for maintenance
  - Installation trades
    - New platform
    - Major modification to existing platform
  - Access to module for testing and R/R
    - Access points for testing
    - Space to open covers/doors
    - Room to attach cabling and hoses
- Special Tooling/Support Equipment

Unique Identification (UID)

- Total Asset Visibility (TAV)
- Pedigree of the weapon system
- Real-time information
- History of the item (how many times it has come back, maintenance history, repair history, FRACAS)
- By tracking at the LRM level, faster trends, design implementation, and design changes
are identified (as long as it is the same format/fit/function)

Storing

- Storing
  - Less storing space required for LRMs due to smaller size
  - Under 250 lbs can utilize overnight express shipping
    - Less docking space required
    - Less time to transport
    - May reduce the need of special storage containers (i.e.; ISOPODS)
  - Reduce the footprints in supply

Sparing

- Spare the high failure LRMs vs. LRUs
  - Quantity based on weighted failure rates
- Spare testing

	MTBF
REX Unit	16,300
Receiver	190,000
Preprocessor	79,000
Waveform Gen	75,000
Transmit Drive	88,000
Local Oscillator	93,000
Linear Regulator	202,000
Chassis	332,000

Much higher quantity to spare at LRU level

Higher quantity in spares for these 2 LRMs

LRM delivers much less redundant supply – Supply more representative of the actual failure items.

National Defense Industrial Association

Summary

Raytheon

- Therefore LRMs can significantly reduce the logistics footprint due to fewer spares quantity and smaller physical dimensions of each spare.
- Reduced O&S cost can be achieved due to:
  – Decreased MTTR (Mean Time To Repair)
  – Requires less manpower effort to accomplish remove/replace
  – Minimized spare investment based on reliability at the lower level (LRM) of the weapon systems
  – Less special support equipment
  – Reduce shipping cost and faster shipping turnaround time

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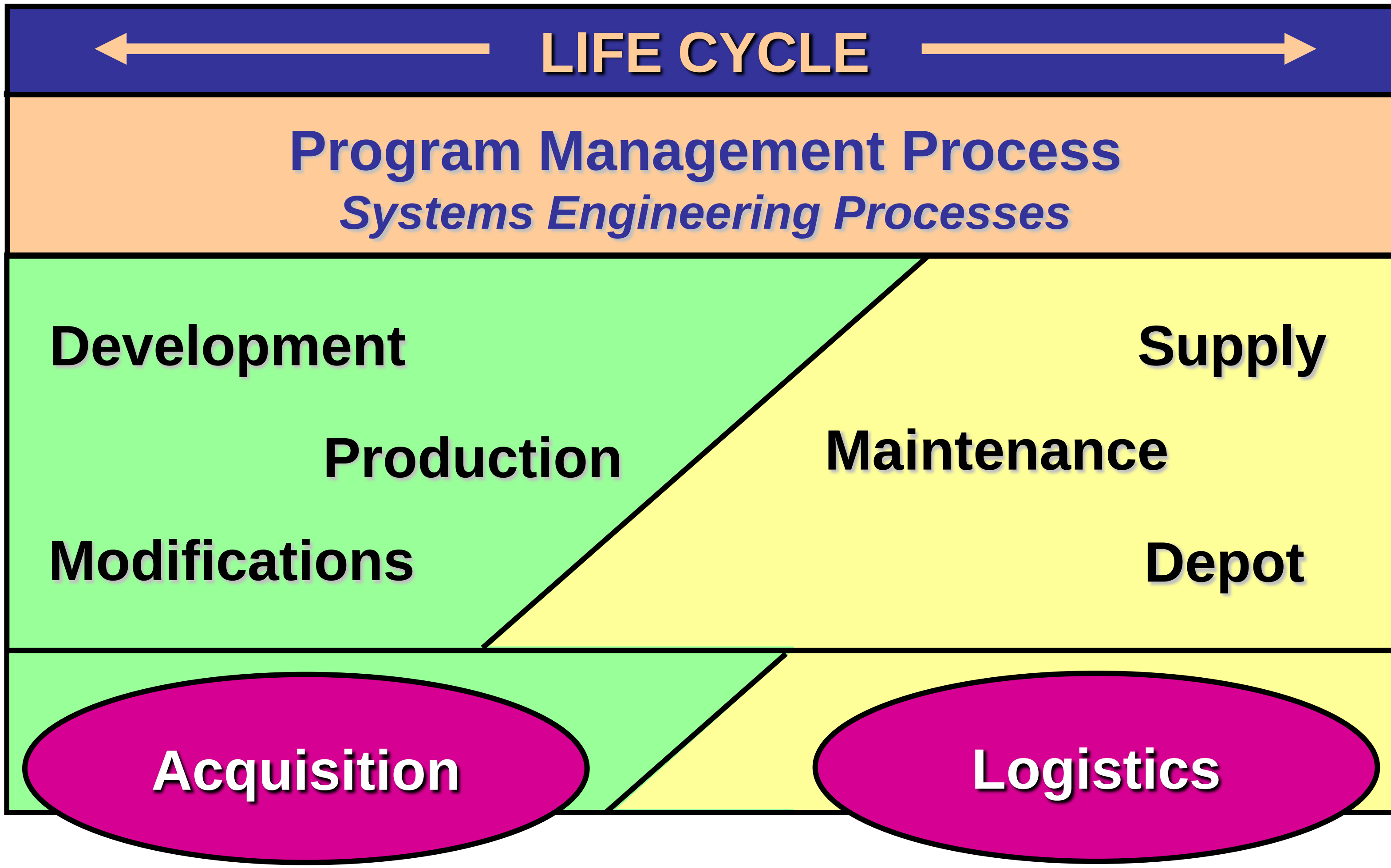
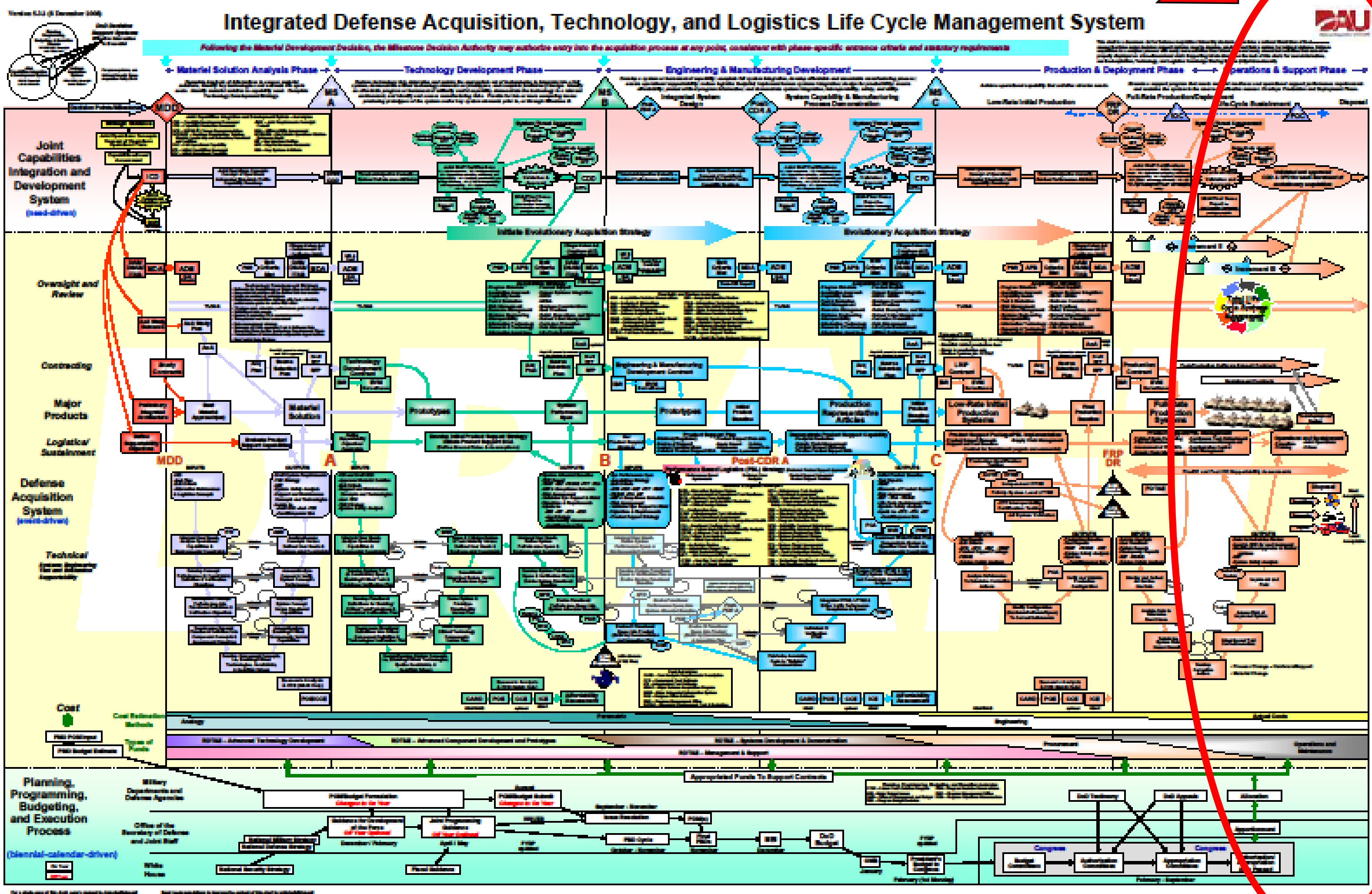
Applying Systems Engineering to Fielded Weapon Systems and End-Items

Mr. Mike Ucchino, Chief
Applications and Development Division
AF Center for Systems Engineering
WPAFB, OH
29 Oct 09

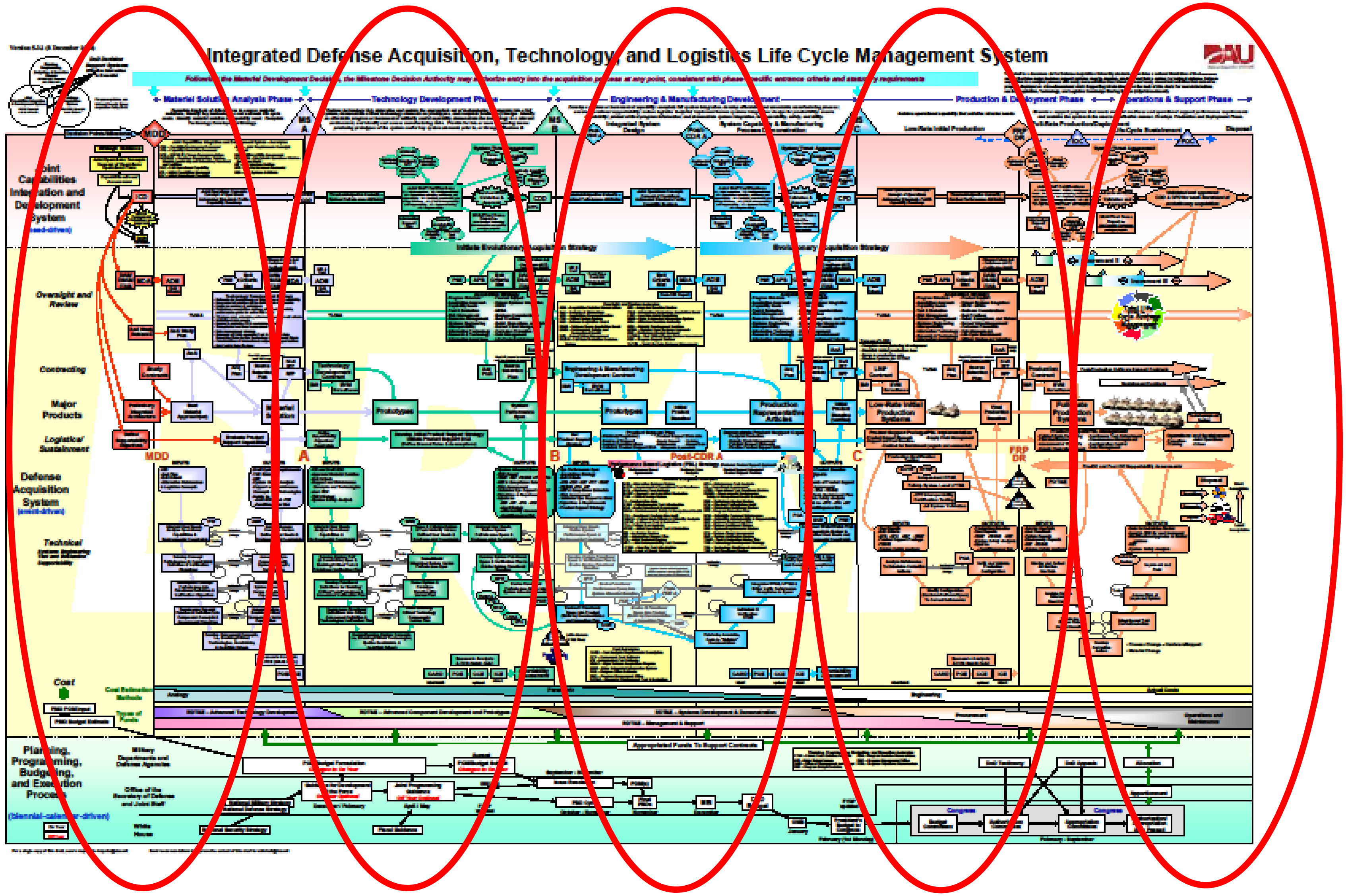
Product Life Cycle



Sustainment View of DoD 5000.02



Real View of SE Process



Incorrect Assumptions

- **Developers work with a blank canvas – sustainers are given a painted picture**
  - Once a concept is created, the canvas is no longer blank for anyone
  - It becomes a continuous improvement/refinement process from that point on
- **Sustainment SE processes are different than acquisition SE processes**
  - Processes and process objectives are the same
    - Process implementation can vary
    - Organizational responsibility can vary
    - Domain knowledge required can vary
  - Every cycle through the SE process reassesses prior decisions for cost, schedule, and performance soundness

SE Processes per DAG Chapter 4

Technical Management Processes	Technical Processes

Technical Management Processes

- Decision Analysis
- Technical Planning
- Technical Assessment
- Requirements Management
- Risk Management
- Configuration Management
- Technical Data Management
- Interface Management

Technical Processes

- Stakeholders Requirements Definition
- Requirements Analysis
- Architectural Design
- Implementation
- Integration
- Verification
- Validation
- Transition

Some SE Process Examples

- **Technical Planning (e.g. SEP)**
  - Modifications
  - Engineering authority / MRBs
  - CCB procedures / membership
  - OSS&E characteristics
  - Data repository
  - Master documentation updates
  - Maintenance data systems
  - etc

SE Processes independent of color of money!!

- **Risk (Opportunity) Management**
  - New technology considerations
  - Disposition of DMS issues
  - Resolution of aging issues
  - TOC reductions
  - etc

SE Processes – Plain English

Technical Processes

- Analyze customer needs
- Convert customer needs into system level performance requirements
- Allocate and derive system level performance requirements into performance requirements for system pieces
- Develop design solutions for performance requirements of system pieces
- Verify design solution meets performance requirements
- Validate design solution satisfies customer needs

Can't Buy Parts – Now What?

- **Buy enough spares to last through the product's remaining life**
- **Cannibalize parts from other systems and end-items in the inventory**
- **Acquire technical data/rights and qualify (1) a new supplier or (2) in-house production**
- **Qualify a new design to an existing performance specification**
  - One for one
  - Many for one (e.g. replace 3 existing boxes with 1 new box)
- **No data available case**
  - Identify/measure operational environment
  - Define requirements and conduct tests to compare existing part with new part
  - Use new part if as good or better than existing one

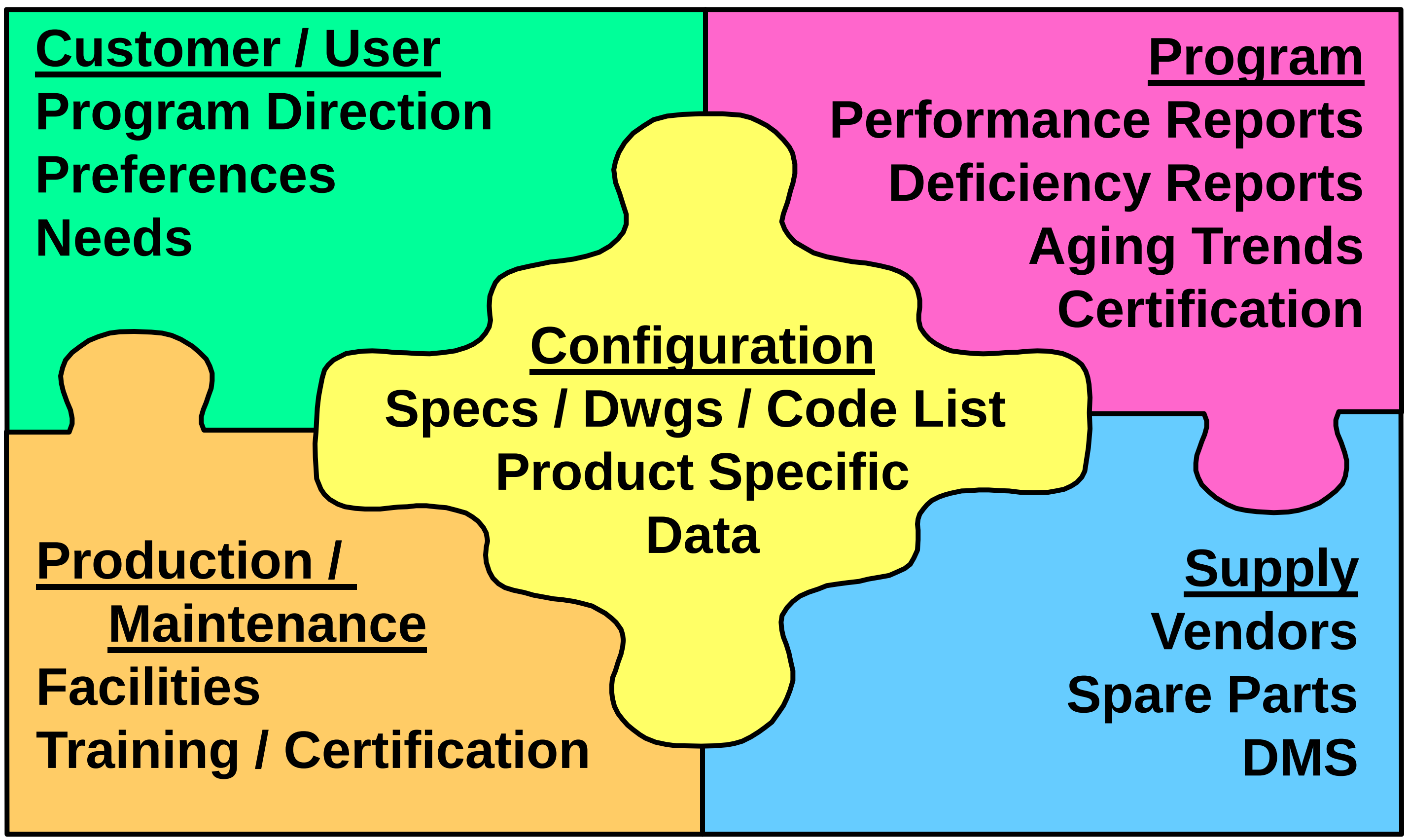
SE Sustainment Tasks

SE Processes – Plain English

Technical Management Processes

- Make technical decisions
- Plan the technical management of the program
- Conduct technical studies
- Analyze technical information
- Document decisions
- Develop backup approaches for risky areas
- Manage technical changes
- Develop and **maintain** technical information

Technical Baseline

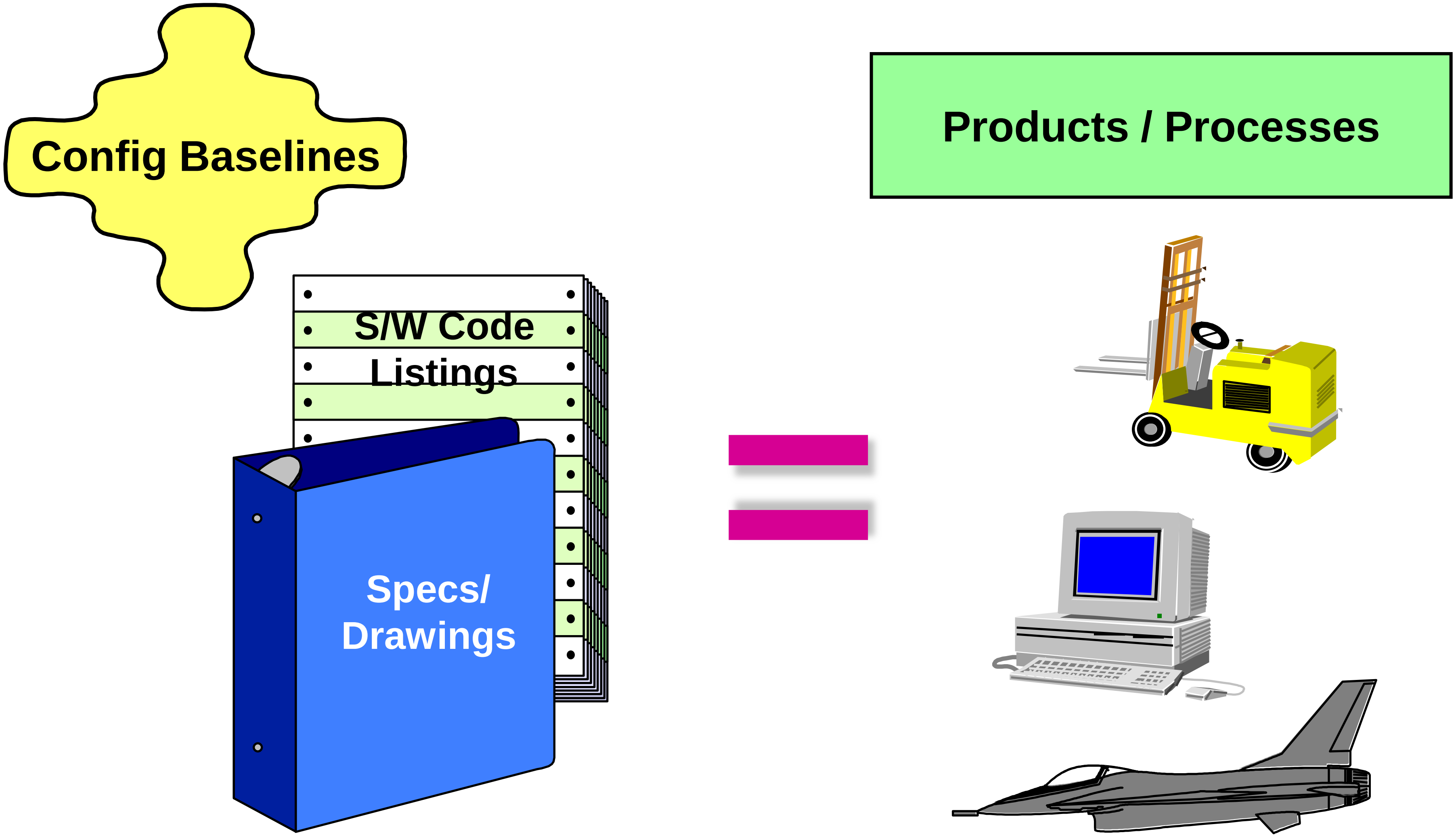


Technical Baseline

- ***Definition*** **–** all of the technical information needed to support a product throughout its life cycle
- **Many different approval processes involved**
  - Configuration change control
  - Maintenance procedures
  - Verification
  - Validation
  - Certification
  - etc
- **All of the information needs to be archived and maintained throughout a product's life cycle**

Configuration Information

Configuration Baselines



Configuration Baselines

Performance Based

FUNCTIONAL (CONCEPT) BASELINE

1. Performance Requirements – System
2. Verification Methods (Qualification) – System

ALLOCATED (DEFINITION) BASELINE

1. Performance Requirements – System Pieces
2. Verification Methods (Qualification) – System Pieces

Design Based

PRODUCT (BUILD) BASELINE

1. Design solutions (dwgs, code listings) – System Pieces
2. 1st Article Reqts – System Pieces
3. Lot / Acceptance & Inspection Reqts – System Pieces
4. Verification Methods (1st Article, Lot / Acceptance) – System Pieces

Specifications

- ***Definition*** **–** contains both requirements and verification methods in one “document”
  - Requirement documents (SRDs/TRDs) missing verification methods
- **Product types**
  - System
  - Item
  - Software
  - Process
  - Material
- Other types include – Interface
  - Don’t buy interfaces -- buy to an interface

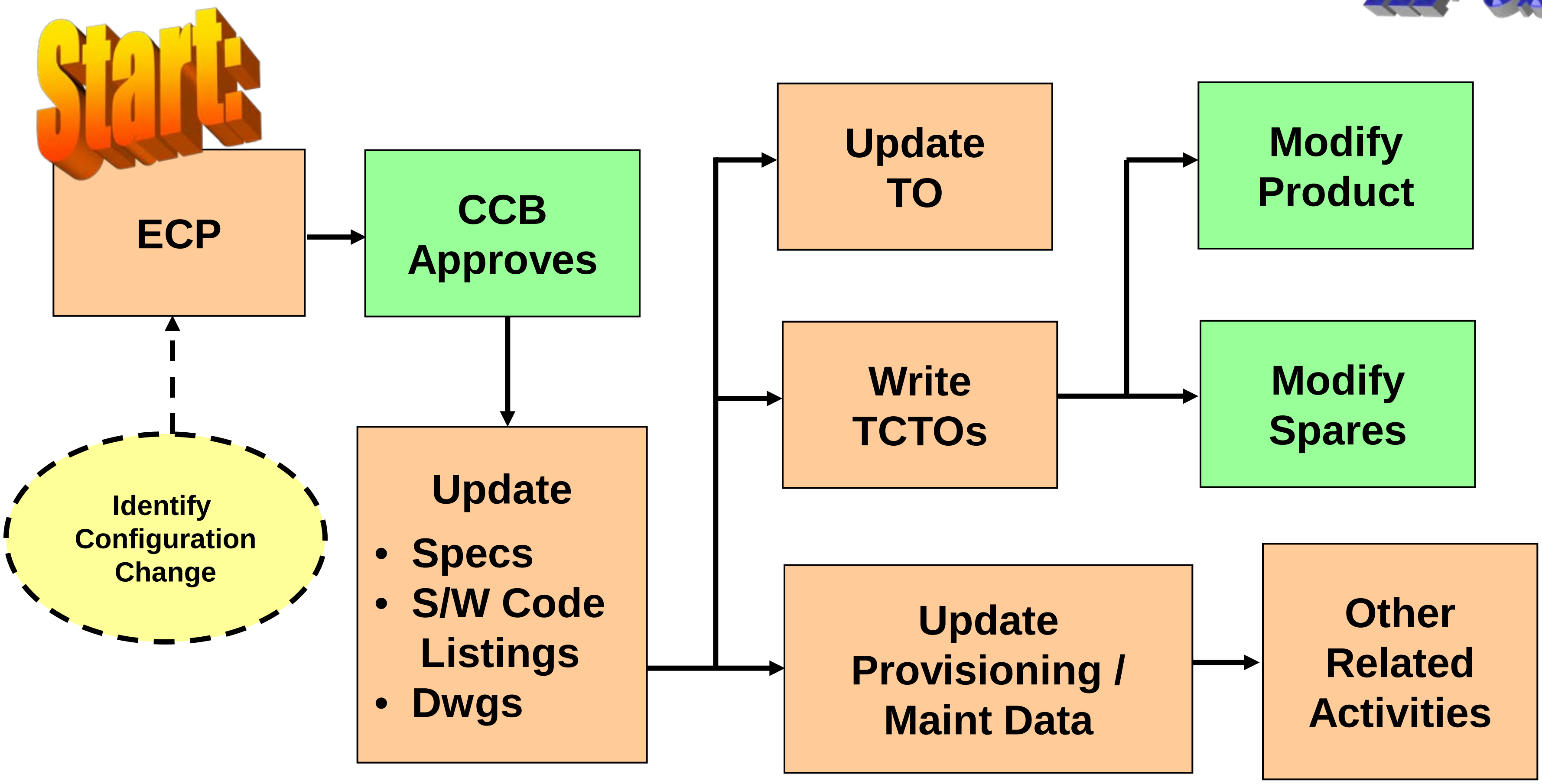
Configuration Baseline Control

- **Configuration Control Boards (CCBs)**
  - Focus on configuration baseline documentation
  - Engineering change proposals (ECPs)
  - Non conformance (waivers, deviations, variances, etc)
  - Can be used to establish baselines

- **ECP Classification**
  - Class I
    - Change form, fit, or function
    - Note: Changing the length of a decal is a Class I change
  - Class II
    - Everything else (minor corrections)

Defining Class I as gov't control and Class II as contractor control is incorrect

Configuration Changes



The PM Is Responsible For The Data

Configuration Baseline Control

- **Material Review Boards (MRBs)**
  - Used to disposition minor non conformances
  - Mirrors Class II ECP approval / delegation
- **Critical / Major Non Conformances**
  - Requires CCB approval
- **Supply Prime Vendor Contracts**
  - May allow parts substitution
  - Changes the configuration when it happens

Product Specific Data

- **Requirements and interface management information not incorporated into configuration baseline documentation**
- **Actual product configuration**
  - Product built against a specific configuration
    - Part numbers / serial numbers / lot numbers / stock numbers / etc
    - Maintenance procedures and data
    - Verification / validation reports
    - Etc
- **Verification information / tools**
  - Test plans / procedures
    - Demonstrated performance / market standards
  - Number of test articles / test sequence
  - Modeling and simulation tools
  - Analytical tools

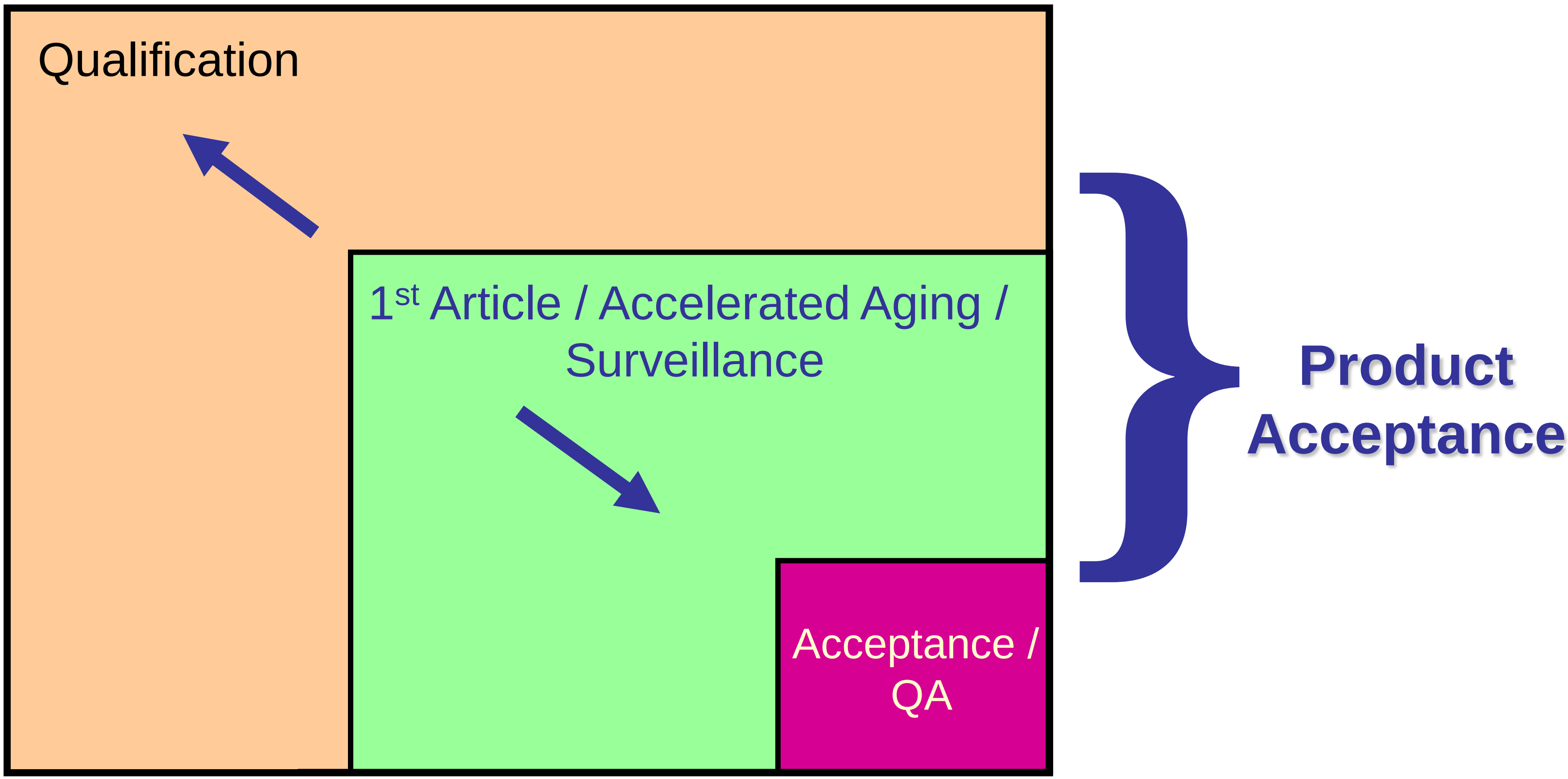
Verification / Validation

Verification / Validation

- ***Verification:*** Satisfies configuration baselines
  - Developmental test and evaluation
  - Usually performed by contractor with government observation

- ***Validation:*** Satisfies customer / operational user needs (i.e. capabilities)
  - Operational test and evaluation
  - Performed by customer or operational user

Verification



Verification

Gov't Development:

Define Requirements	Design Product	Verify Product Meets Requirements

Commercial Buy:

Define Requirements	Select Product	Verify Product Meets Requirements

Final Thoughts

- **F^3I (Form, Fit, Function, & Interface) Replacement**
  - New component **must** be verified
  - Really **F^2I:** form changes
- **Depot**
  - The **only** engineering authority the depot has is what it's given in the Work Specification
  - Work Specification mandates maintenance procedures depot is to use to make repairs
    - Phrase – Make "X" repair using best commercial practice – gives depot authorization to use their own repair procedures
  - Same Work Specification used for both in-house and contracted depot work

Final Thoughts

- **Government Supply Chain Managers**
  - **Not** program managers
  - Responsible for stock, store, and issue tasks only
  - DLA Directive 3200.1 states services **retain** engineering and configuration management responsibility for the parts DLA buys
    - Applies even if not classified as a critical safety item
- **Can't find old performance specifications – check out bidder packages / CDs**

Questions ?

Developing an Introductory Course in:

Model-Based Systems Engineering (MBSE) with the Systems Modeling Language (SysML)

Joe Wolfrom

October 29, 2009

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION
STRENGTH THROUGH INDUSTRY & TECHNOLOGY

The Johns Hopkins University
APPLIED PHYSICS LABORATORY

Outline

- **Purpose of the Presentation**
- **MBSE/SysML Course Challenge**
- **Course Background Information**
  - Context
  - Purpose
  - Demographics
  - Text and Software Used
  - Coverage
  - Course Schedule
  - Typical Class Structure
  - Hands-on Projects
  - Development Details
- **Summary and Take-aways**
- **What's Next**

Purpose of the Presentation

- **Discuss experiences developing and teaching a course in MBSE with SysML**
  - Discuss challenge of teaching a course in MBSE with SysML
  - Discuss course background information
  - Discuss techniques employed to enhance student learning

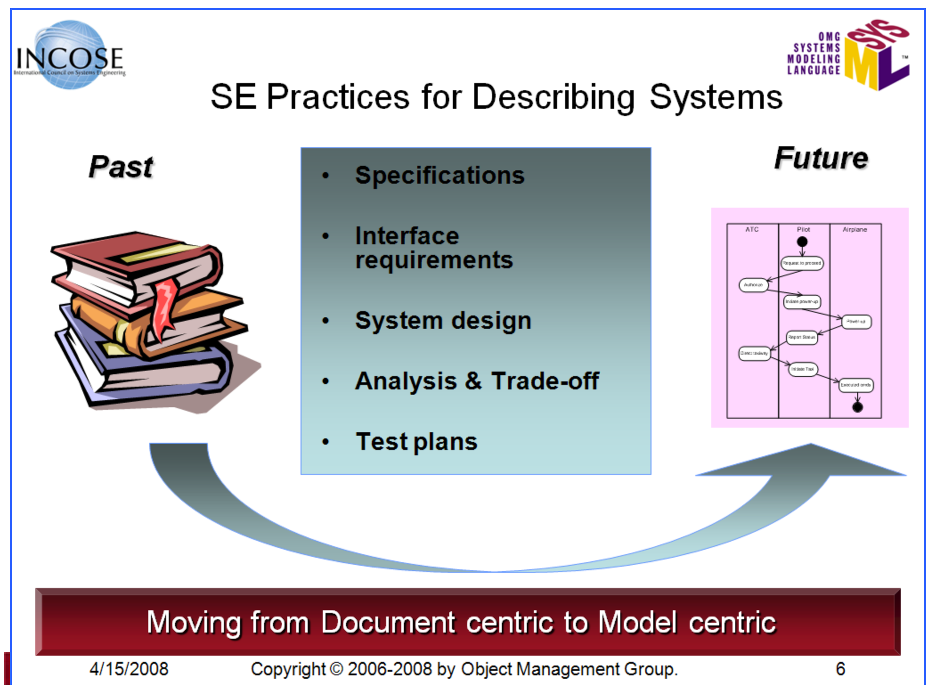
MBSE/SysML Course Challenge

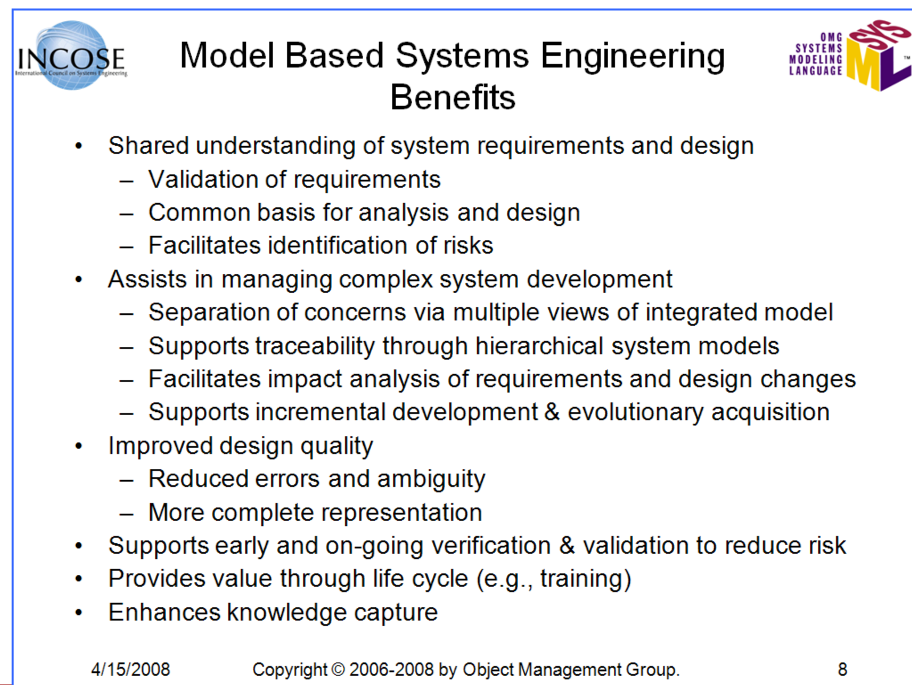
- **Develop an in-house course in MBSE with SysML**
  - Goal: Teach concepts as well as practical application
  - Develop an effective alternative to the ‘all-day’ seminar
    - Fire-hose effect - too much info to absorb in a short period of time
    - Good for overviews but not enough hands-on learning
- **Bottom-line**
  - Provide students with training needed to apply SysML concepts and the use of a modeling tool to their current projects

Course Background Information

Course Background Information - Context

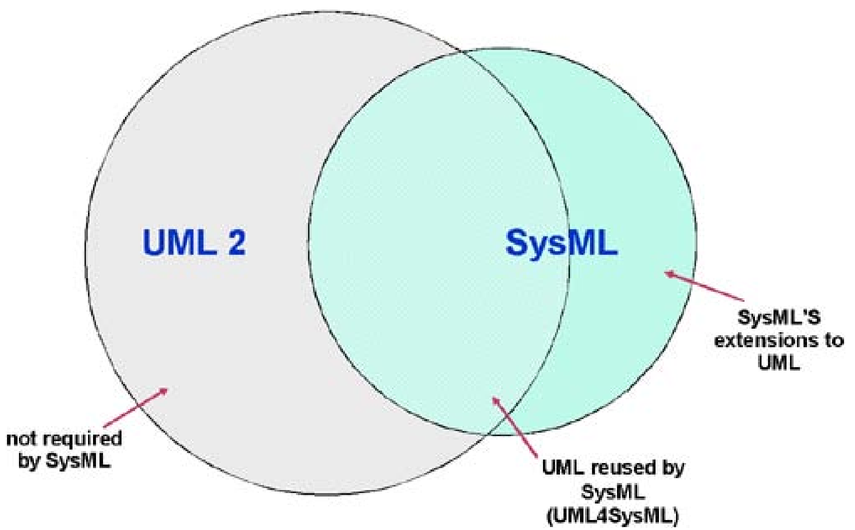
- **MBSE**
  - MBSE is the formalized application of modeling to support systems requirements, design, analysis, verification, and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases. [INCOSE, Systems Engineering Vision 2020, Version 2.03, Sept 2007]

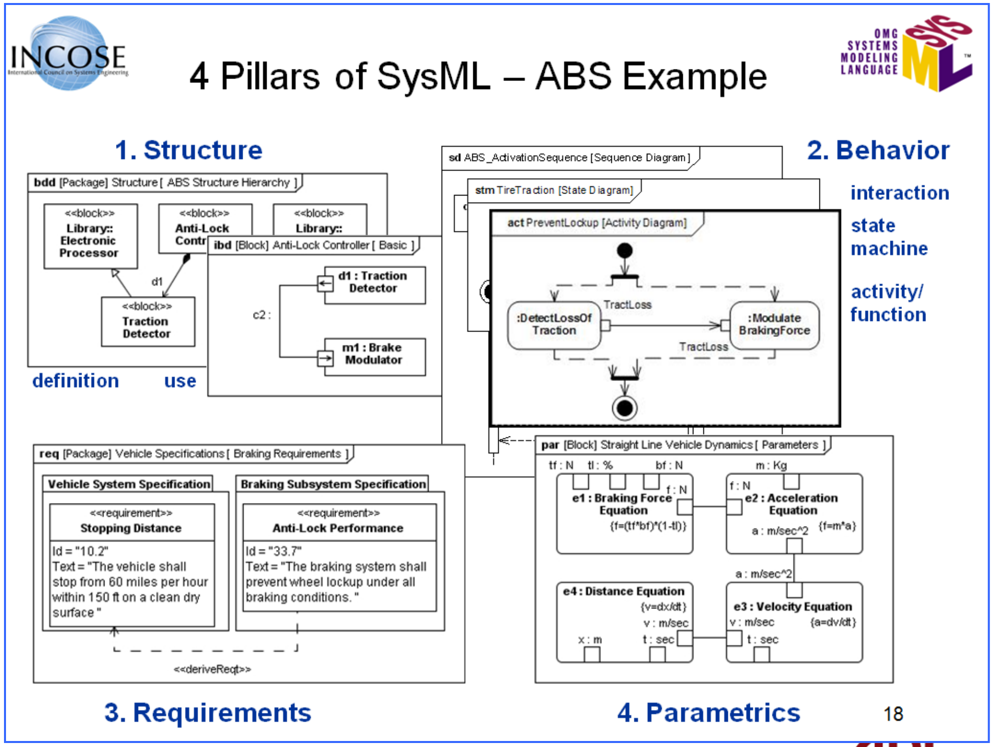




Course Background Information - Context

- **SysML**
  - SysML is a general purpose graphical modeling language that supports the analysis, specification, design, verification, and validation of complex systems. [Friedenthal, Moore, and Steiner, A Practical Guide to SysML, p. 29]





Course Background Information - Purpose

- **Teach MBSE, SysML concepts, and tool use to JHU/APL technical staff members**
  - Introduce Model Based Systems Engineering
  - Introduce and teach SysML concepts and techniques
  - Demonstrate and teach use of modeling tool to produce SysML artifacts
- **Motivation**
  - Increased awareness and use of MBSE and SysML
  - Application of concepts to projects
  - Increase staff awareness and comfort level with tool usage
- **Course Objectives**
  - Learn the basics of MBSE and SysML
  - Learn the basics of a SysML-based Tool
  - Practice application of basics to develop system models

Course Background Information - Demographics

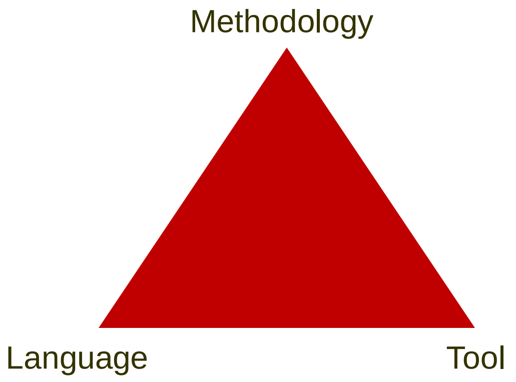
- **Student Information**
  - 18 Students (15 local, 3 remote)
  - Systems Engineering background
  - No prior MBSE knowledge required or assumed
  - No prior SysML or UML knowledge required or assumed
  - No prior SysML-based tool use required or assumed
- **Strategic Education Program (SEP) courses at JHU/APL**
  - Courses for JHU/APL technical staff – taught by JHU/APL staff
  - Non-credit
  - Pass/Fail

Course Background Information - Text and Software Used

- **Course Text**
  - “A Practical Guide to SysML: The Systems Modeling Language”; Friedenthal, Moore and Steiner; 2008; Elsevier, Inc.
- **Course Software**
  - Sparx Systems “Enterprise Architect” (EA) Ultimate Edition version 7.5 (with SysML)
    - Academic Licenses for instructors and students
    - Instructor experience
  - Cisco MeetingPlace
    - Remote student participation
    - Recorded sessions (presentations and voice)
  - Microsoft SharePoint
    - Posting Course Material

Course Background Information - Coverage

- **Three things required for modeling:**
  - Language
  - Tool
  - Methodology
- **Focus of this course is:**
  - Language (SysML)
  - Tool (EA)
- **Several MBSE Methods available**
  - Survey of Model-Based Systems Engineering Methodologies [INCOSE –TD-2007-003-01, 10 June 2008, Estafan]
- **SysML and EA are methodology-independent**
  - SysML concepts and the EA tool can be applied to various MBSE methodologies
  - Language and Tool study provide the foundation for Methodology study
  - Detailed look at methodologies – good candidate for follow-on course

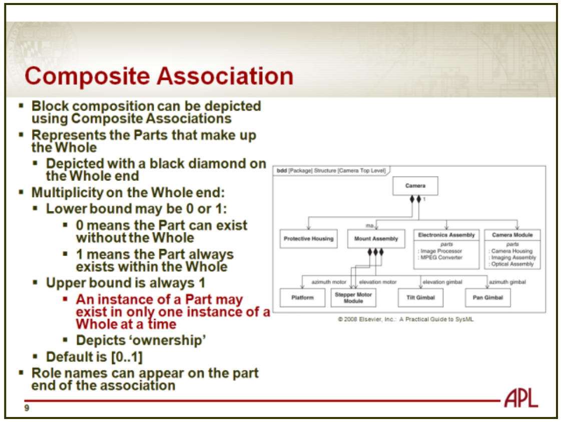


Course Background Information - Course Schedule

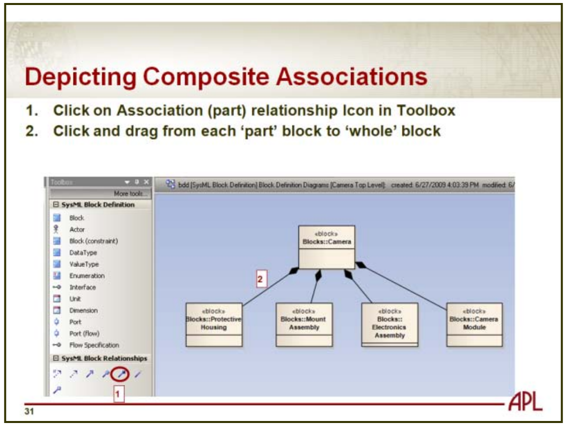
Week	Date	Hour	Topic
1	9/8	1&2	Course Overview, Systems Engineering Overview, Model Based Systems Engineering Overview, and SysML Overview
2	9/15	1&2	Organizing the Model with Packages and EA Basics
3	9/22	1&2	Modeling Requirements and their Relationships
4	9/29	1&2	Motivation for MBSE and SysML
5	10/6	1&2	Modeling Functionality with Use Cases
6	10/13	1&2	Modeling Structure with Blocks (Block Definition Diagrams)
7	10/20	1&2	Modeling Flow-Based Behavior with Activities
8	10/27	1&2	Modeling Event-Based Behavior with State Machines
9	11/3	1&2	Modeling Message-Based Behavior with Interactions
10	11/10	1&2	Modeling Structure with Blocks (Internal Block Diagrams)
11	11/17	1&2	Modeling Constraints with Parametrics
12	11/24	1&2	Modeling Cross-Cutting Relationships with Allocations

Course Background Information - Typical Class Structure

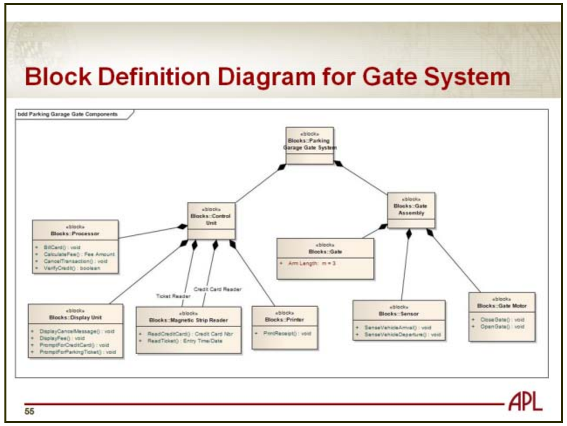
1. Homework Review
2. Motivation: Why Model <subject> Diagrams ?
3. Language: Concepts (from textbook)
4. Tool: Using EA to create <subject> Diagrams
5. Modeling Example: In-Class Project (automated parking garage gate)
6. Homework Assignment



Language



Tool



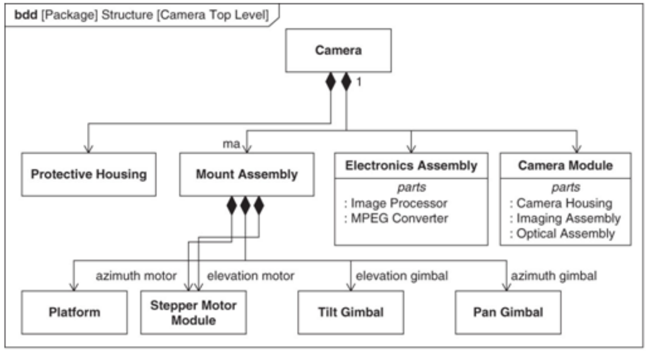
Model

Sample Language Concepts Slide

- Introduction of SysML elements and relationships with a graphic example of each

Composite Association

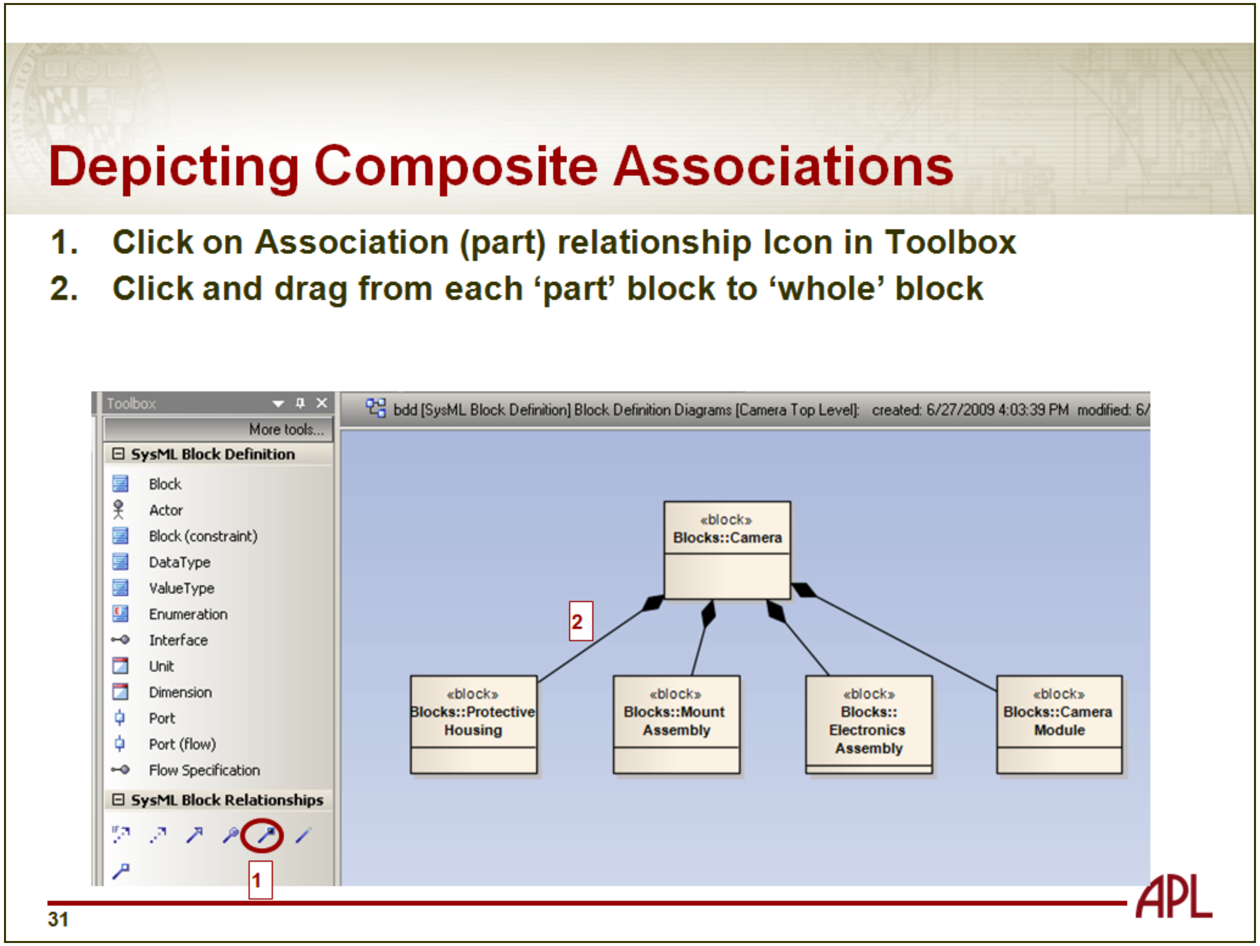
- Block composition can be depicted using Composite Associations
- Represents the Parts that make up the Whole
  - Depicted with a black diamond on the Whole end
- Multiplicity on the Whole end:
  - Lower bound may be 0 or 1:
    - 0 means the Part can exist without the Whole
    - 1 means the Part always exists within the Whole
  - Upper bound is always 1
    - An instance of a Part may exist in only one instance of a Whole at a time
    - Depicts 'ownership'
  - Default is [0..1]
- Role names can appear on the part end of the association



APL

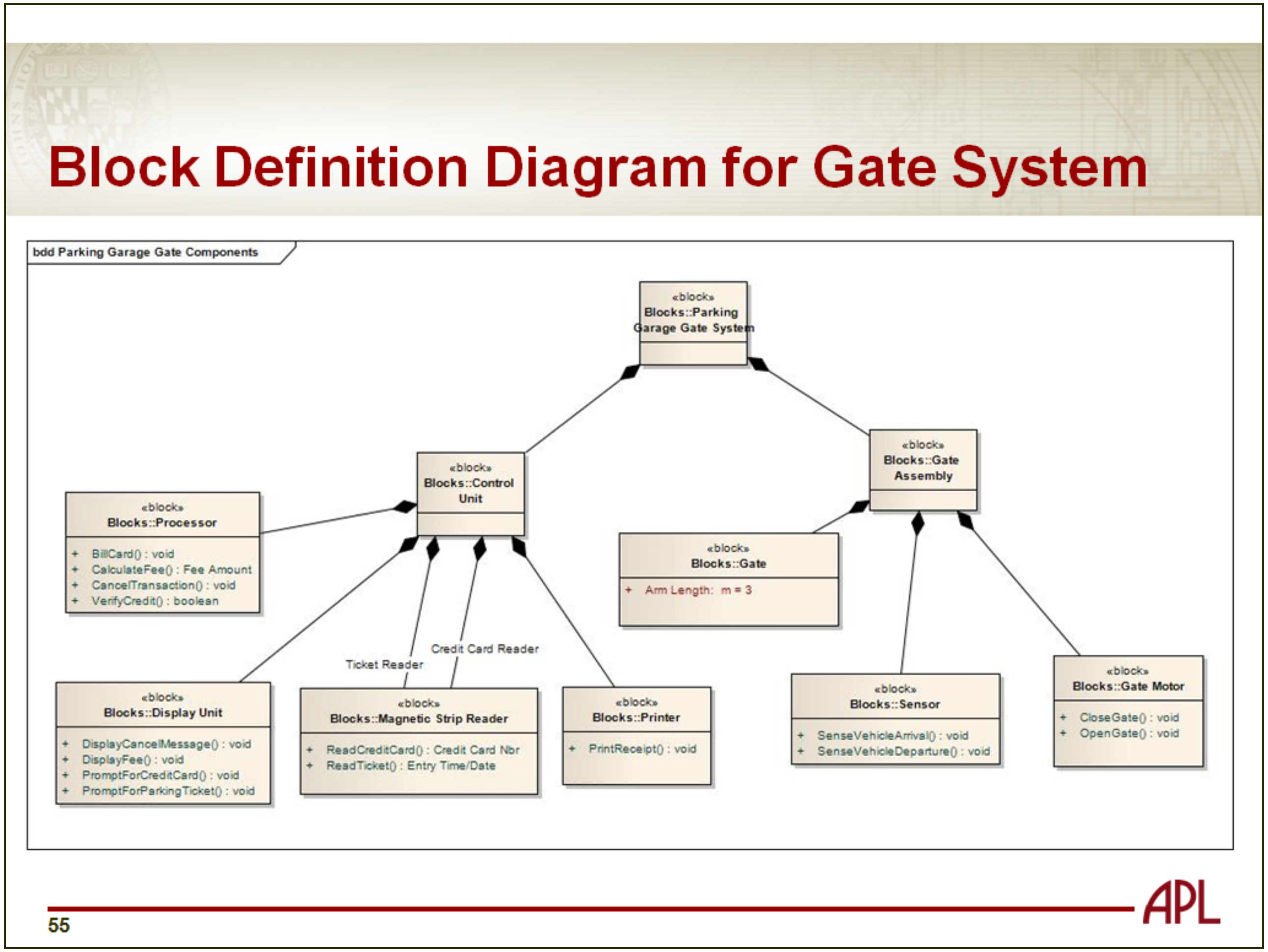
Sample EA Tool Slide

- Step by step instructions using EA screen captures
- Simultaneous EA tool display demonstrating steps using EA
- Students practice using their own laptops



Sample Modeling Example Slide

- Combining SysML concepts and tool usage to build a SysML artifact for an in-class ‘real-world’ project system



Course Background Information - Hands-on Projects

- **Homework Systems**
  - Alarm Clock Radio
  - Coke Machine
- **Why?**
  - Familiarity
  - Relatively simple systems (as compared to examples in text)
  - Compare and contrast student models
  - Practice
- **Group Homework Projects**
  - Students working in teams on homework

Course Background Information - Development Details

- **Course Philosophy**
  - **Need to practice modeling to learn it – course needs to be hands-on**
  - **Minimalistic approach**
    - Focus of course is on the basics (not complete coverage)
    - Just enough to whet the appetite without being overwhelming
  - **Learn-a-little / Practice-a-little approach**
    - Two hour classes / once a week / twelve weeks
      - One chapter of textbook per week
    - Benefits
      - Immediate practice of learned concepts
      - Allows one week of practice for concepts to 'sink-in'

Course Background Information - Development Details

- **Section Development Process**
  - **Create 'Reader's Digest' version of a chapter from the text**
    - Extract information appropriate for an Introductory class
    - Create or extract graphics to illustrate each concept
    - Create SysML Concepts slides using information from book and corresponding graphics
  - **Create EA Tool slides**
    - Develop step-by-step process for utilizing the SysML concept within the EA Tool
    - Capture EA screens in order to 'visualize' the process
    - Create slides relating process steps to screen captures
  - **Create Modeling Example slides**
    - Apply concepts and process steps discussed to a real-world system
    - Create slide(s) capturing model depiction

Course Background Information - Development Details

- **Course Material Peer Review**
  - All course material was presented at INCOSE OOSEM Working Group meetings for review and comment
  - INCOSE OOSEM Working Group consists of subject-matter experts with numerous years of experience in Systems and Software Engineering, MBSE, UML, and SysML
    - Includes textbook co-author (Sandy Friedenthal)
  - Course material was reviewed incrementally by the Working Group
    - Course Outline
    - Section Development
    - On-going input and feedback through Course Presentations
    - Planned: Contributions to post-course improvements

Summary and Take-aways

MBSE/SysML courses should include adequate:

- Visual learning techniques by using graphical examples of language concepts and graphical depictions of step-by-step tool usage (visual learning)
- In-class instructor-lead demonstrations of the modeling tool (learning through demonstrations)
- In-class hands-on training with a modeling tool (learning by doing)
- Time between sessions to give students time to learn and practice the concepts outside of class (incremental learning / “sink-in” time)
- Homework projects for the students to model to apply the concepts that they have learned to sample systems (learning through practice)
- Group homework (collaborative learning)
- Peer review of course matter with subject-matter experts (course validation and verification)
- Remotely accessible and recordable sessions for remote (or absent) students (remote learning)

What's Next

- **Finish teaching current course (Nov 24th)**
  - Course Evaluation
  - Perform Course assessment
  - Implement improvements
- **Develop 'Methodology' Course as a follow-on to this Introductory course**
- **Investigate offering course publicly as an elective in the Johns Hopkins University Engineering for Professionals Master's Degree program in Systems Engineering**

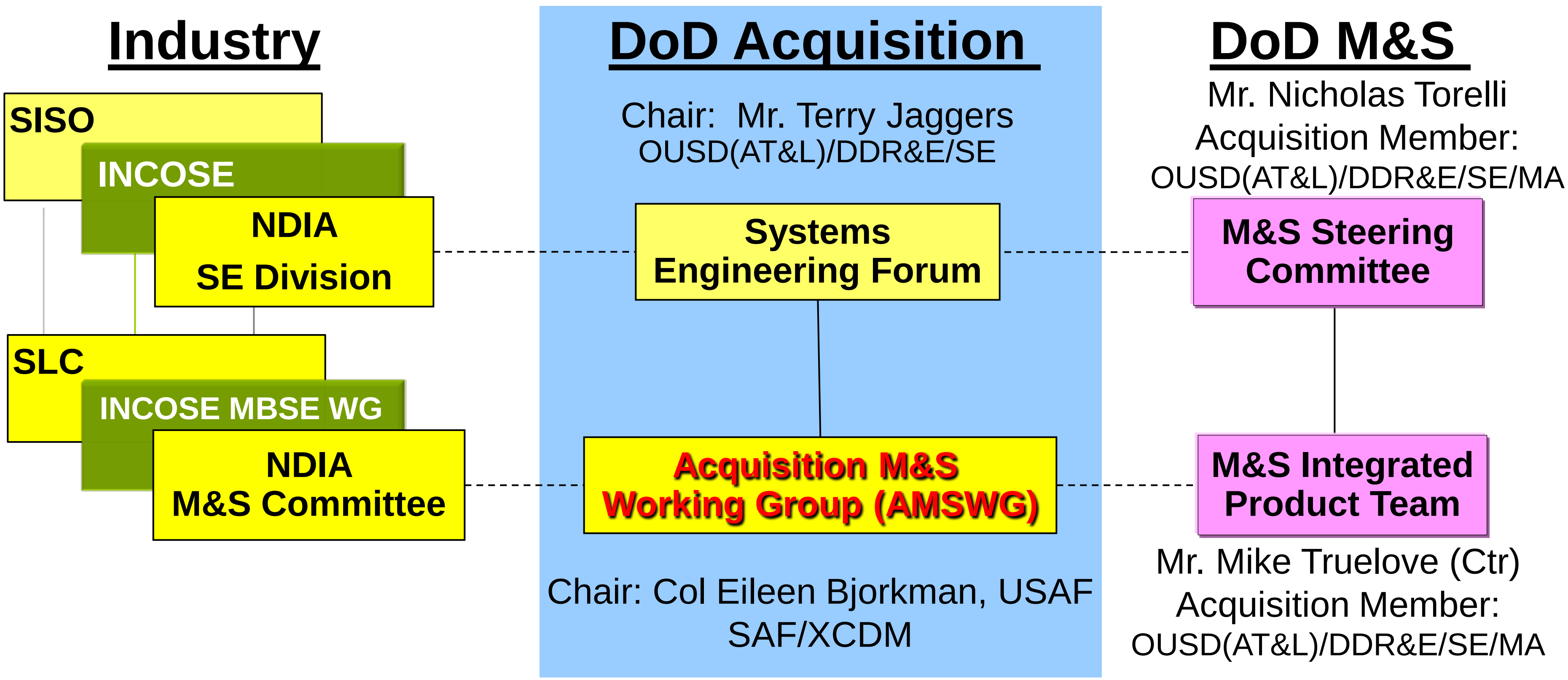
Questions

Update of the Acquisition Modeling and Simulation Master Plan

Stephen J. Swenson, AEgis Technologies Group
Acquisition M&S Community Lead
Systems Engineering Directorate
Office of the Director, Defense Research and Engineering

12th Annual NDIA Systems Engineering Conference
October 29, 2009

Acquisition M&S Governance Structure



AMSWG Charter (SE Forum, 2006)

- **Assist PMs and acquisition professionals by improving the utility of M&S . . .**
- **Address common concerns, improve info flow, align technical initiatives, pursue cross-cutting issue resolution . . .**
- **Represent the acquisition community in DoD M&S deliberations . . .**

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Current AMSMP

Objective 1

Provide necessary policy and guidance

1-1 M&S management
1-2 Model-based systems engineering & collaborative environments
1-3 M&S in testing
1-4 M&S planning documentation
1-5 RFP & contract language
1-6 Security certification

Objective 2

Enhance the technical framework for M&S

2-1 Product development metamodel
2-2 Commercial SE standards
2-3 Distributed simulation standards
2-4 DoDAF utility
- a) DoDAF 2.0 Systems Engineering Overlay
- b) Standards for depiction & interchange

2-5 Metadata template for reusable resources

Objective 3

Improve model and simulation capabilities

3-1 Acquisition inputs to DoD M&S priorities
3-2 Best practices for model/sim development
3-3 Distributed LVC environments
- a) Standards
- b) Sim/lab/range compliance
- c) Event services

3-4 Central funding of high-priority, broadly-needed models & sims
- a) Prioritize needs
- b) Pilot projects
- c) Expansion as warranted

Objective 4

Improve model and simulation use

4-1 Help defining M&S strategy
4-2 M&S planning & employment best practices
4-3 Foster reuse
- a) Business model
- b) Responsibilities
- c) Resource discovery

4-4 Info availability
- a) Scenarios
- b) Systems
- c) Threats
- d) Environment

4-5 VV&A
- a) Documentation
- b) Risk-based
- c) Examination

4-6 COTS SE tools
4-7 M&S in acqn metrics

Objective 5

Shape the workforce

5-1 Definition of required M&S competencies
5-2 Harvesting of commercial M&S lessons
5-3 Assemble Body of Knowledge for Acqn M&S
5-4 M&S education & training
- a) DAU, DAG & on-line CLMs
- b) Conferences, workshops & assist visits

5-5 MSIAC utility

<u>Key</u>

Broader than Acqn

Circumstance

- **Acquisition Modeling and Simulation Master Plan (AMSMP)**
  - Signed out April 17, 2006
  - Forty actions designed to:
    - Foster widely-needed M&S capabilities beyond the reach of individual programs
    - Better enable acquisition of effective joint capabilities and systems-of-systems
    - Empower program and capability managers by removing systemic M&S obstacles, identifying new options for approaching tasks, and helping support widely-shared needs.
    - Promote coordination and interface with M&S activities of the DoD Components.
- **M&S Steering Committee requires that each community develop and maintain a business plan**
- **Update required for 2010 to feed development of DoD's Common and Cross-Cutting Business Plan**

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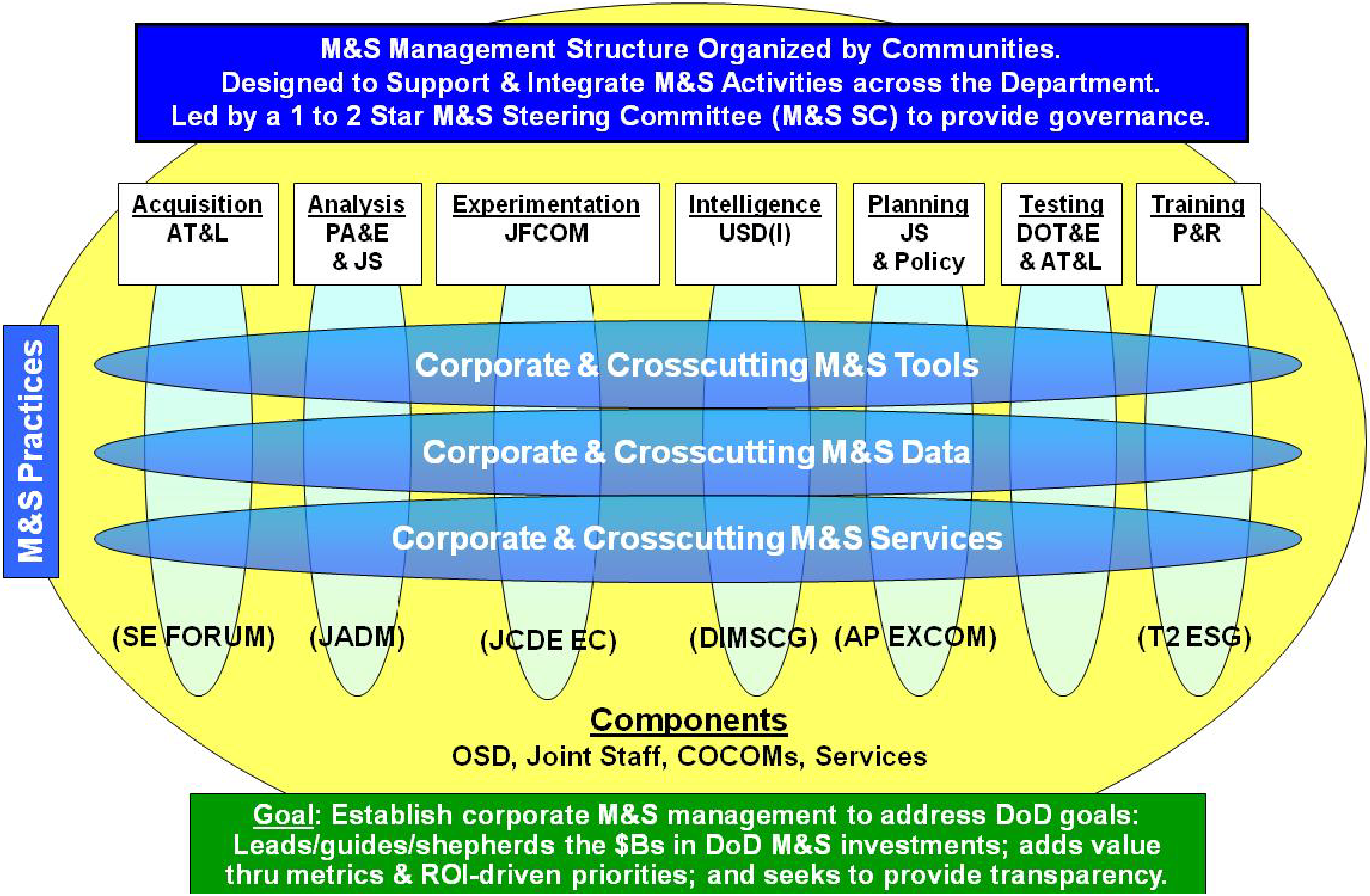
DoD Modeling & Simulation Governance



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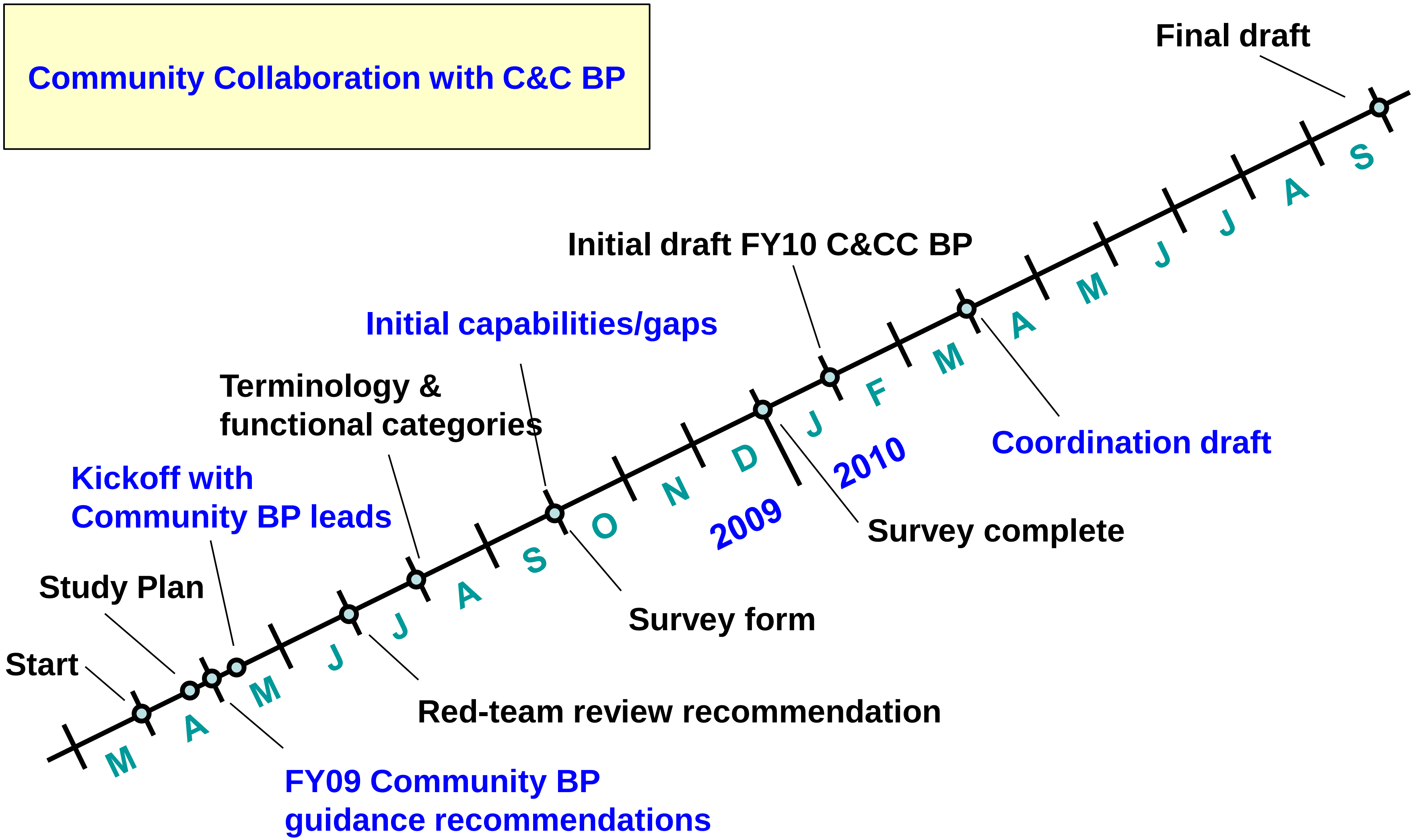
C&C BP Target Timeline



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Our Contribution

- **Description of the "To-Be" State – Vision**
- **Description of the "As-Is" State – Capabilities**
  - Tools
  - Data
  - Services
- **Capability Gaps**
- **Initiatives / Actions**

- **Acquisition Community M&S Business Plan**

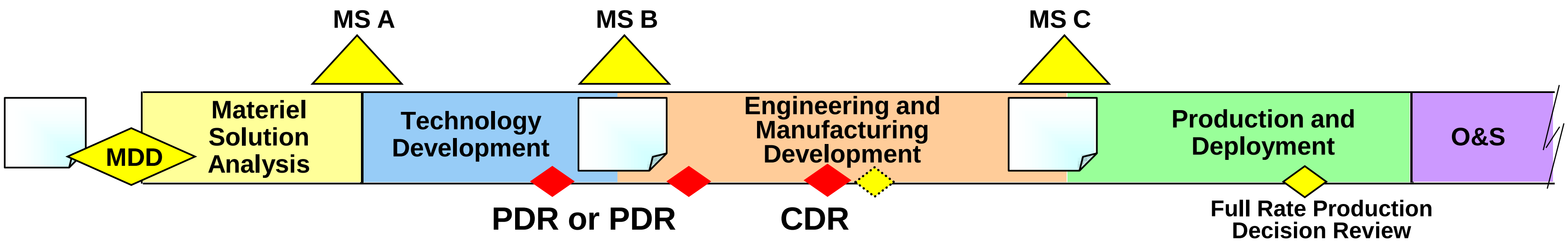
Update AMSMP

- **Completed by end of CY2009**
- **Current AMSMP is our departure point**
  - Maintain objectives
  - Most actions will carry-over, update as required to reflect progress, policy change, results of studies, etc
  - Completed actions will be replaced by their follow-on actions
  - New actions will be added to reflect change in business, policy and technology
- **Structure will change**
- **Heavy reliance on the Acquisition Modeling and Simulation Working Group (AMSWG)**

End Result

- **Provide cogent guidance for choosing projects and influencing other acquisition community M&S**
  - Metrics for selecting appropriate, cost-effective projects traceable to requirements
  - Defined interfaces to other projects and activities
  - Aligning influence on other acquisition M&S
- **Enable systematic integration and evaluation of components as they are produced & assembled**
- **Allows for visible progress assessment against the vision, holding ourselves accountable**
- **Provide mechanism for iterating requirements, needed actions, and the plan accordingly**
- **Provide guidance for influencing policies and other's activities**

M&S Activities During Acquisition



Develop M&S requirements (SEP) Model and data discovery (SEP) Develop M&S Configuration Management Strategy (SEP) Assign Lifecycle Maintenance Responsibilities of Data and Models (SEP, RFP) Define role of M&S throughout the lifecycle Review and identify appropriate standards for M&S reuse and interoperability (SEP, RFP) Develop/Modify Required M&S Accredit applicable M&S capabilities Publish descriptions of M&S capability developed in this phase. Asses required data ownership/use rights and accessibility (development RFP, materiel RFP)	Develop M&S requirements (SEP) Influence Acquisition Strategy to address modeling and simulation requirements and use. Document role of M&S in testing and initiate identification of required M&S assets Initiate discussion of requirements for use of M&S in operational test w/OT community (TEMP) Update SEP based on evolving M&S requirements Develop/modify required M&S including virtual prototype Accredit applicable M&S capabilities Publish descriptions of M&S capability developed in this phase. Review data and ownership rights (materiel RFP)	Develop M&S requirements (SEP) Develop/modify required M&S Accredit applicable M&S capabilities Publish descriptions of M&S capability developed in this phase. Review data and ownership rights (LRIP RFP)	Identify opportunities for M&S reuse for operations (e.g. training, decision support, etc) Develop/modify required M&S Accredit applicable M&S capabilities Publish descriptions of M&S capability developed in this phase. Review data and ownership rights (Full Rate RFP)	Capture data to strengthen M&S for operational use and feedback to other programs. Reuse/repurpose M&S for operational use (e.g., training, decision support, etc)

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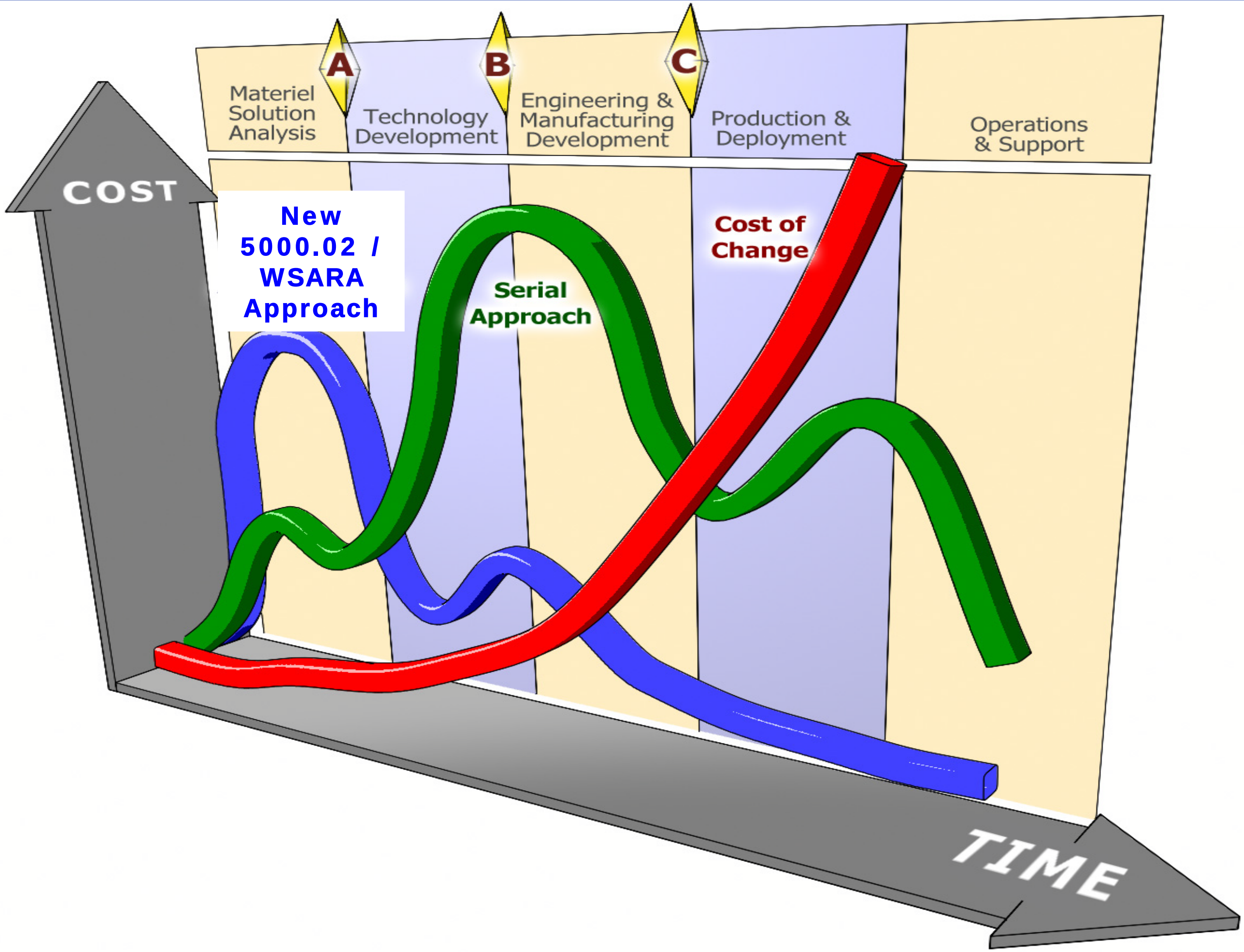
Early Involvement (Pre-Milestone A) Will Reduce Total Ownership Cost



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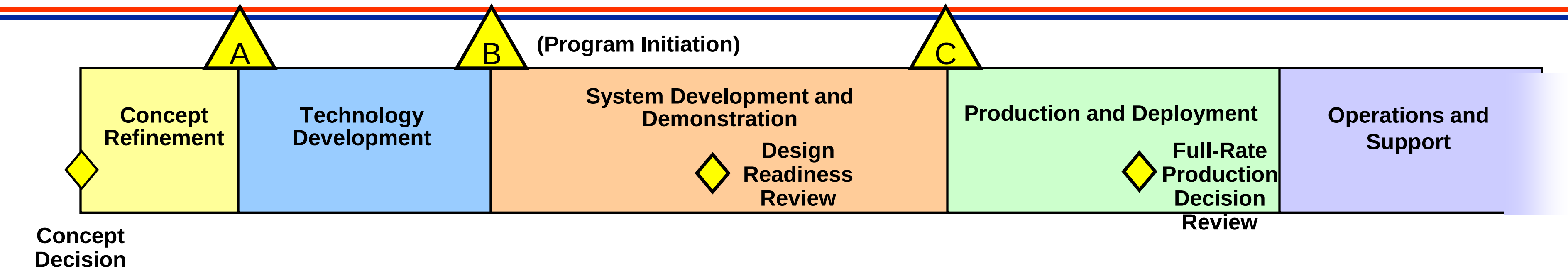
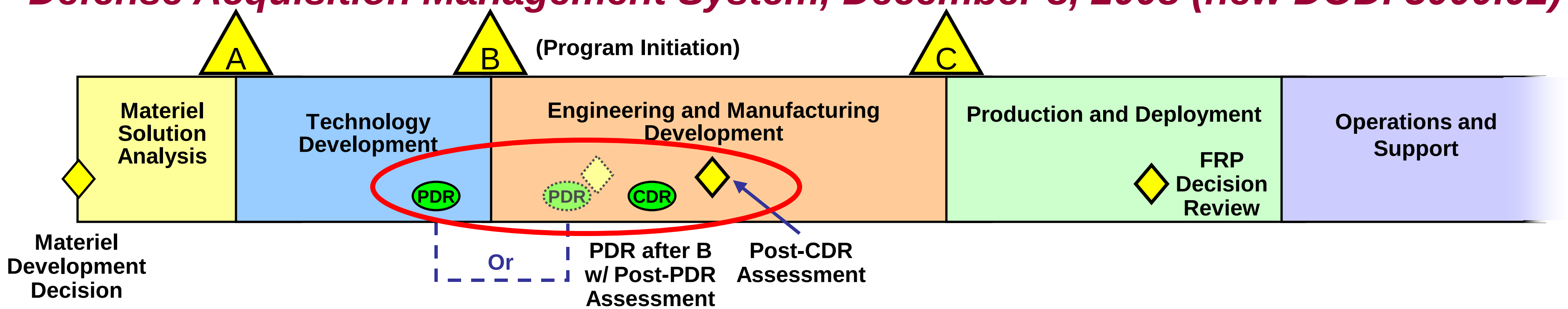
Acquisition Lifecycle Comparisons

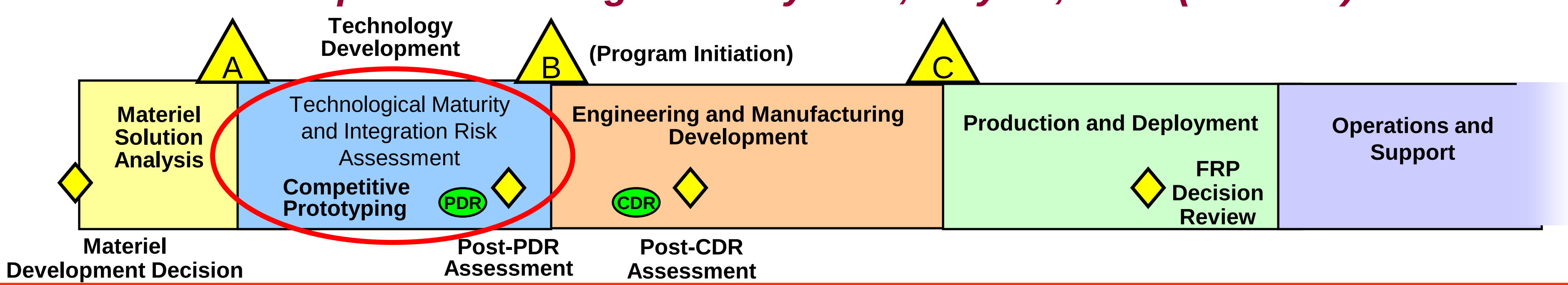
Defense Acquisition Management System, May 12, 2003



Defense Acquisition Management System, December 8, 2008 (new DODI 5000.02)



Defense Acquisition Management System, May 22, 2009 (WSARA)



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Acquisition M&S Master Plan Update Process

(Top-down)

Desired Acqn Environment per CJCSI 3170, DoDD 5000.01, WSARA

Identify Needed System Engineering Capabilities

Jan '10 — Acquisition M&S Master Plan

Determine & Prioritize What Acqn Community Must Do

Identify Actions of Others (e.g., M&S CO, NII, NIST) — Dec '09

Identify Actions Needed to Address the Gaps — Nov '09

Identify M&S Capability Gaps — Sep-Oct '09

Identify Needed M&S Capabilities

Assess Current Issues/Needs (e.g., Systems of Systems efforts)

Assess Recommendations fm Prior M&S in Acqn Studies

(Bottom-up)

Policy/Guidance Reference Documents

1.DoD Directive 5000.1, "The Defense Acquisition System," May 12, 2003
2.DoD Directive 5000.59, "DoD Modeling and Simulation (M&S) Management," August 8, 2007
3.Chairman of the Joint Chiefs of Staff Instruction 3170.01G, "Joint Capabilities Integration and Development System," March 1, 2009
4.DoD 5025.1-M, "DoD Directives Systems Procedures," October 28, 2007
5.DoDD 8320.2, "Data Sharing in a Net-Centric Department of Defense," December 3, 2004
6.DoD 5000.59-M, "Glossary of Modeling and Simulation Terms," January 15, 1998
7.Defense Acquisition University, "Glossary of Acquisition Acronyms and Terms," July 2005
8."Defense Acquisition Guidebook, Version X.Y," November 1, 2006
9.DoD Instruction 5000.2, "Operation of the Defense Acquisition System," Dec 8, 2008
10."Federal Acquisition Regulation," March 31, 2008
11.DoD Instruction 8500.2, "Information Assurance (IA) Implementation," February 6, 2003
12."DoD Architecture Framework," April 23, 2007
13.DoDI 5000.61, "DoD Modeling and Simulation (M&S) Verification, Validation, and Accreditation (VV&A)," May 13, 2003
14. Revision to T&E Policy; Memorandum; December 22, 2007
15. DoD M&S Human Capital Strategy (DRAFT)
16. Implementing a Life Cycle Management Framework; DTM; July 31, 2008
17. Weapons Systems Acquisition Reform Act; May 22, 2009

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Needed Systems Engineering Capabilities

SE1	Early, continuing systems engineering from an SoS/FoS capabilities perspective; seamless transition from JCIDS to acquisition
SE2	Lifecycle-wide exploration of the maximum available trade space, including time-phased requirements and technology insertion
SE3	Collaboration among multiple organizations, Service & contractors for all key enterprise-level SE decisions
SE4	Comprehensive, accurate, early assessment of designs; avoidance of costly fixes for problems discovered late in the acquisition process
SE5	Tighter decision cycles (faster design-assessment process)
SE6	More effective & efficient testing, including in a SoS/FoS environment
SE7	Appropriate reuse of all resources -- information, software tools, expertise, facilities, ranges, etc -- across programs & organizations

M&S Processes for Better Systems Engineering

MS1	**Use of a model-based engineering approach**
MS2	**Establishing M&S-enabled collaborative engineering environments**
MS3	**Model-Test-Model process to improve both M&S tools and testing**
MS4	**Harnessing M&S knowledge to formulate an effective M&S strategy**
MS5	**Disciplined M&S planning and employment**
MS6	**Efficient development/maintenance of credible M&S tools**
MS7	**Access/sharing of authoritative data needed for M&S representations**
MS8	**Inspection of M&S used and cost burden that inhibits M&S use**

	A	B	C	D	E	F	G	H
1	M&S PROCESS DESCRIPTION					CAPABILITY(IES)	GAP	METRIC
2	MS1	Use of a Model-Based Engineering (MBE) Approach				Individual acquisition programs are beginning to employ MSBE through vendor offerings.		Number of acquisition programs which have employed MSBE (up-good). Number of unique MSBE approaches
3	MS1.1		Published Model-Based Engineering approach(es).			Vendors of systems engineering tools have develop MSBE approaches. INCOSE MSBE Methodology Survey articulates several extant	The DoD has not adopted a particular MSBE approach(es).	
4	MS1.1.1			Approach(es) for the application of M&S to				
5	MS1.1.2			Approach(es) for the application of M&S to Systems				
6	MS1.1.3			Approach(es) for the application of M&S to Design				
7	MS1.1.4			Approach(es) for the application of M&S to Test and				
8	MS1.2		An acquisition workforce that understands the principles and value of a Model-Based Systems Engineering Approach					
9	MS1.2.1			Body of Knowledge for Model-Based Systems Engineering.		SimSummit Body of Knowledge. AFAMS BoK outline. INCOSE Systems Engineering BoK.	Current M&S BoK lacks significant content describing the principles and value of MSBE. **G39 Body of Knowledge for M&S support to acquisition is**	
10	MS1.2.2			Educational opportunities provided by government and academia.				
11	MS1.2.2.1				Education for acquisition program managers on the value and application of MBSE	Coursework developed under the "Educating the Acquisition Workforce" high level task -- available through Naval Post Graduate School. M&S for Acquisition Continuous Learning Module (CLM) Test and Evaluation CLM offered through the Defense Acquisition University.	Current educational opportunities lack significant MSBE content. **G38 No consensus on the value of integrated architectures, nor responsibility for. G40 Acqn community managers and staffs mostly uninformed about M&S capabilities and limitations. G42**	Number of acquisition PM-track professionals and military personnel enrolled in government-sponsored courses that, as a minimum, address the value of MSBE. (up-good)
12	MS1.2.2.2				Education for the general acquisition professional including systems engineers.			Students enrolled in government-sponsored MSBE courses. (up-good)
13	MS1.2.2.3				Education for the modeling and simulation professional with particular emphasis on building capability for reuse across lifecycle, organizational and corporate boundaries.	Coursework developed under the "Educating the Acquisition Workforce" high level task -- available through several universities. Other Universities are beginning to offer degrees in modeling and simulation (e.g., Old Dominion, Georgia Tech, U. Alabama Huntsville)	Some U.S. colleges/universities offer either coursework/seminars dedicated to MSBE or apply MSBE to other academic ends. Examples include: University of Michigan offers seminars on MSBE. MIT offers a professional short course entitled: "Systems Engineering, Architecture and Lifecycle Design: Principles, Models, Tools, and Applications." Boston University offers courses in modeling and simulation within their Division of Systems Engineering / College of Engineering. INCOSE maintains a directory of academic institutions that offer educational opportunities in Systems Engineering:	Number of colleges/universities offering instruction in MSBE. (up-good)
14	MS1.3			Personnel competence				
15	MS1.3.1				Standards of professional competence in MSBE.	Certification criteria for modeling and simulation professionals as reflected in the NTSA Certified Modeling and Simulation Professional program. Systems Engineering professional competencies are under development and are expected to be complete in	Need cogent standards for professional competence using MSBE based on Systems Engineering knowledge, skills and abilities.	Standards exist.
16	MS1.3.2				Professional certification for Civil Servants	DAWIA (Systems Engineering, Program Management), Certified M&S Professional (NTSA). Heavily influenced by M&S for DoD	Current certifications are for general modeling and simulation. No certification for MSBE competence.	Number of certified professionals both in and out of government. (up--good). Number of weapons systems acquisitions

MS1 / MS2 / MS3 / MS4 / MS5 / MS6 / MS7 / MS8

Ready

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Gap Examples

- Body of Knowledge for M&S support to acquisition is deficient, not managed—lacks specific guidance for MBE.
- The DoD has not adopted a particular MBE approach(es).
- No DoD requirement for formal M&S planning to support acquisition (other than T&E).
- Need ability to identify competent personnel in industry offerings to the government.
- An overabundance of capabilities that essentially accomplish the same thing leads to an almost indecipherable landscape. Need to focus attention in one direction and merge capabilities from the others.
- Use of DoD-unique standards limits their user base, quality, COST tool support, and opportunities for reuse.
- The average producer of modeling and simulation capability has little knowledge of the existence, value or use of currently available discovery metadata specifications.

Business Ecosystem

"An economic community supported by a foundation of <u>interacting organizations</u> and individuals – the organisms of the business world. This economic community produces goods and services of value to customers, who themselves are members of the ecosystem. The member organizations also include <u>suppliers, lead producers, competitors and other stakeholders</u>. Over time, they <u>coevolve their capabilities</u> and roles, and <u>tend to align themselves</u> with the directions set by one or more central companies. Those companies holding leadership roles may change over time, but the function of ecosystem leader is valued by the community because it enables members to move toward shared visions to align their investments and to find mutually supportive roles."

James F. Moore, *The Death of Competition – Leadership and Strategy in the Age of Business Ecosystems*, Harper Business, New York, 1996.

Measures to Assess an Ecosystem's Health

- **Productivity**
  - The ability of the ecosystem to continually transform technology and raw materials of innovation into lower costs and new products
- **Robustness**
  - An ecosystem's ability to survive major disruptions, such as those caused by unpredictable technological innovation and change
- **Niche Creation**
  - Ability of an ecosystem to increase meaningful diversity through the creation of valuable new functions, or niches

Iansiti, Marco and Levien, R; "Strategy as Ecology", *Harvard Business Review,* March 2004

Principles of the Ecosystem Model

- "Open system": organic systems exist in a continuous exchange with their environment, characterized by a continuous cycle of input, internal transformation (throughput), output, and feedback.
- Homeostasis: self-regulation and the ability to maintain a steady state achieved through processes that regulate and control system operation on the basis of "negative feedback" whereby deviations from some standard norm initiate actions to correct the deviation.
- Entropy/negative entropy: closed systems are entropic in that they have a tendency to deteriorate and run down. Open systems seek to sustain themselves by importing energy – they are characterized by negative entropy.
- Structure, function, differentiation, and integration: relationship between these concepts is crucial to understanding living systems as they are closely intertwined.
- Requisite variety: the internal regulatory mechanisms of a system must be as diverse as the environment with which it is trying to deal.
- Equifinality: in an open system, there may be many different ways of arriving at a given end state.
- System evolution: the capacity of a system to evolve depends on an ability to move to more complex forms of differentiation and integration.[1]
-

[1] Gareth Morgan, *Images of Organization.*

2012 Revision of NAICS

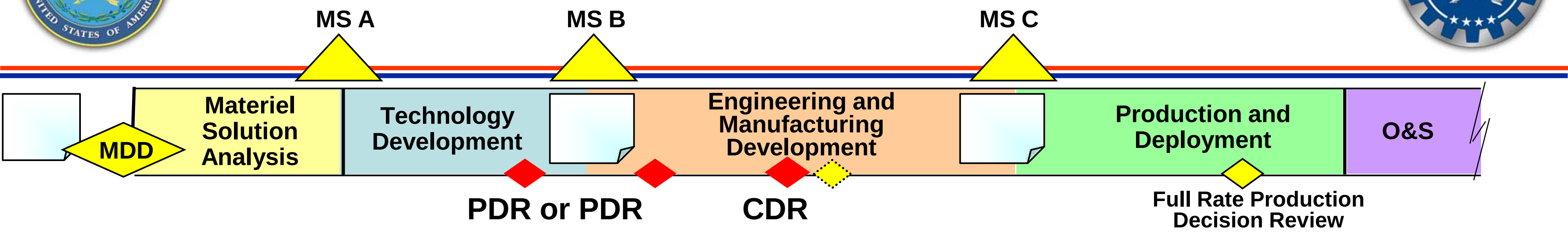
- **Office of Management and Budget (OMB) Federal Register notice soliciting proposals: Late 2008/Early 2009**
  - Released Jan 7 with proposals due April 7
- **U.S. Economic Classification Policy Committee (EPCP) review of proposals and trilateral negotiation: ongoing through 2009**
- **Federal Register notice containing ECPC recommendations to OMB: late 2009 or early 2010**
- **Federal Register notice containing OMB final decisions: May 2010**
- **2012 NAICS United States Manual manuscript submitted to OMB: June 2011**
- **2012 NAICS United States Manuals available: January 2012**

Questions?

Technical Reference Documents

1. *Final Report of the Acquisition Task Force on M&S*, 1994; Sponsor: DDR&E (Dr. Anita Jones); Chair: VADM T. Parker, USN (Ret.)
2. *Naval Research Advisory Committee Report on M&S*, 1994; Sponsor: ASN(RDA); Chair: Dr. Delores Etter
3. *Collaborative Virtual Prototyping Assessment for Common Support Aircraft*, 1995; Sponsor: Naval Air Systems Command; conducted by JHU/APL and NSMC
4. *Collaborative Virtual Prototyping Sector Study*, 1996; North American Technology & Industrial Base Organization; sponsor: NAVAIR
5. *Application of M&S to Acquisition of Major Weapon Systems*, 1996; American Defense Preparedness Association; sponsor: Navy Acqn. Reform Exec.
6. *Effectiveness of M&S in Weapon System Acquisition*, 1996; Sponsor: DTSE&E (Dr. Pat Sanders); conducted by SAIC (A. Patenaude)
7. *Technology for USN and USMC, Vol. 9: M&S*, 1997; Naval Studies Board, National Research Council; sponsor: CNO
8. *A Road Map for Simulation Based Acquisition*, 1998; Joint SBA Task Force (JHU APL lead); sponsor: Acquisition Council of EXCIMS
9. *M&S for Analyzing Advanced Combat Concepts*, 1999; Defense Science Board Task Force (Co-chairs: L. Welch, T. Gold)
10. *Advanced Engineering Environments*, 1999; National Research Council; sponsor: NASA
11. *Survey of M&S in Acquisition*, 1999 and 2002; Sponsor: DOT&E/LFT&E; conducted by Hicks & Associates (A. Hillegas)
12. *Test and Evaluation*, 1999; Defense Science Board Task Force (Chair: C. Fields)
13. *"SIMTECH 2007" Workshop Report*, 2000; Military Operations Research Society (Chair: S. Starr)
14. *M&S in Manufacturing and Defense Systems Acquisition*, 2002; National Research Council; sponsor: DMSO
15. *M&S Support to the New DoD Acquisition Process*, 2004 NDIA Systems Engineering Div. M&S Committee; sponsor: PD, OUSD(AT&L)DS
16. *Missile Defense Phase III M&S*, 2004 Defense Science Board Task Force (Chair: W. Schneider)
17. *Live, Virtual, Constructive Architecture Roadmap*, 2008, JFCOM (Lead: K Goad)
18. *Modeling and Simulation Resource Reuse Business Model*, 2008, Center for Naval Analyses (Lead: D. Shea)

M&S Activities During Acquisition



Develop M&S requirements (SEP) Model and data discovery (SEP) Develop M&S Configuration Management Strategy (SEP) Assign Lifecycle Maintenance Responsibilities of Data and Models (SEP, RFP) Define role of M&S throughout the lifecycle Review and identify appropriate standards for M&S reuse and interoperability (SEP, RFP) Develop/Modify Required M&S Accredit applicable M&S capabilities Publish descriptions of M&S capability developed in this phase. Asses required data ownership/use rights and accessibility (development RFP, materiel RFP)	Develop M&S requirements (SEP) Influence Acquisition Strategy to address modeling and simulation requirements and use. Document role of M&S in testing and initiate identification of required M&S assets Initiate discussion of requirements for use of M&S in operational test w/OT community (TEMP) Update SEP based on evolving M&S requirements Develop/modify required M&S including virtual prototype Accredit applicable M&S capabilities Publish descriptions of M&S capability developed in this phase. Review data and ownership rights (materiel RFP)	Develop M&S requirements (SEP) Develop/modify required M&S Accredit applicable M&S capabilities Publish descriptions of M&S capability developed in this phase. Review data and ownership rights (LRIP RFP)	Identify opportunities for M&S reuse for operations (e.g. training, decision support, etc) Develop/modify required M&S Accredit applicable M&S capabilities Publish descriptions of M&S capability developed in this phase. Review data and ownership rights (Full Rate RFP)	Capture data to strengthen M&S for operational use and feedback to other programs. Reuse/repurpose M&S for operational use (e.g., training, decision support, etc)

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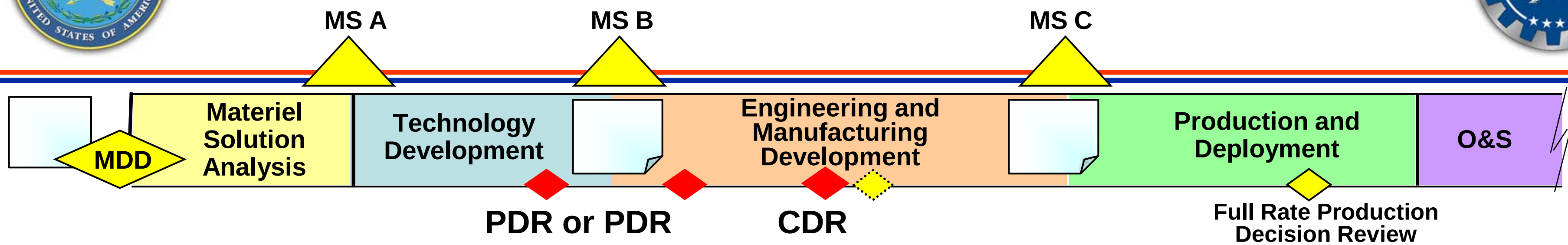
M&S Use During Acquisition



AoA Rapid virtual prototyping Exploration of alternatives and design variations CAD/CAM Promote stakeholder inspection of proposed solution, variations and alternatives Identify cost drivers and risk areas. Conduct initial manpower requirements studies.	System performance analyses (e.g., evaluate Pdet, Pcded, Pk, etc) CAD/CAM Human machine interface design Failure analyses (e.g., stress, fatigue, shock) Conduct manpower requirements studies. Evaluate cost implications Life cycle cost analyses Analyze and assess resource, readiness, and other key life cycle sustainment metrics	Evaluate performance of technology under development. Focus test and evaluation activities CAD/CAM Test and evaluation under conditions otherwise difficult/impossible to replicate (i.e., safety restrictions, environmental restrictions, cost restrictions) Predict human performance as a function of detailed design Anthropometry and biomechanics. Analyze and assess resource, readiness, and other key life cycle sustainment metrics	Design of manufacturing facilities Define production workflow Analyze and assess resource, readiness, and other key life cycle sustainment metrics	Support design and maintenance modifications Evaluate redesign efforts Analyze and assess resource, readiness, and other key life cycle sustainment metrics

NOTE: THIS LIST IS NOT COMPLETE AND GROUPING BY PHASE IN THIS WAY DOES NOT ADEQUATELY COMMUNICATE BROAD-SPECTRUM USE M&S THROUGHOUT THE ACQUISITION PROCESS

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To CJCSI 3170.01G dtd. 1 Mar 2009

Mentioned/implied in the definition of the CDD (evolutionary acquisition)

Key CJCSI 3170.01E Policies

AE1

- *Joint concepts-centric capabilities identification process to allow joint forces to meet the full range of military operations and challenges…*
- *Assess existing and proposed capabilities in light of their contribution to future joint allied and coalition operations. … Produce capability proposals that consider the full range of DOTMLPF solutions in order to advance joint warfighting in a unilateral and multinational context.* AE2
- AE3 *New solution sets…crafted to deliver technologically sound, testable, sustainable and affordable increments of militarily useful capability.*
- *The FoS and SoS solutions may also require systems delivered by multiple sponsors/materiel developers* AE4 AE5
- *The process to identify capability gaps and potential solutions must be supported by a robust analytical process* AE6
- *JCIDS implements a capabilities-based approach that…requires a* AE7 *collaborative process that utilizes joint concepts and integrated* AE8 *architectures to identify prioritized capability gaps and integrated DOTMLPF and policy approaches to resolve those gaps* AE9

Mentioned only in the definition of "Materiel Solution"

Implied throughout

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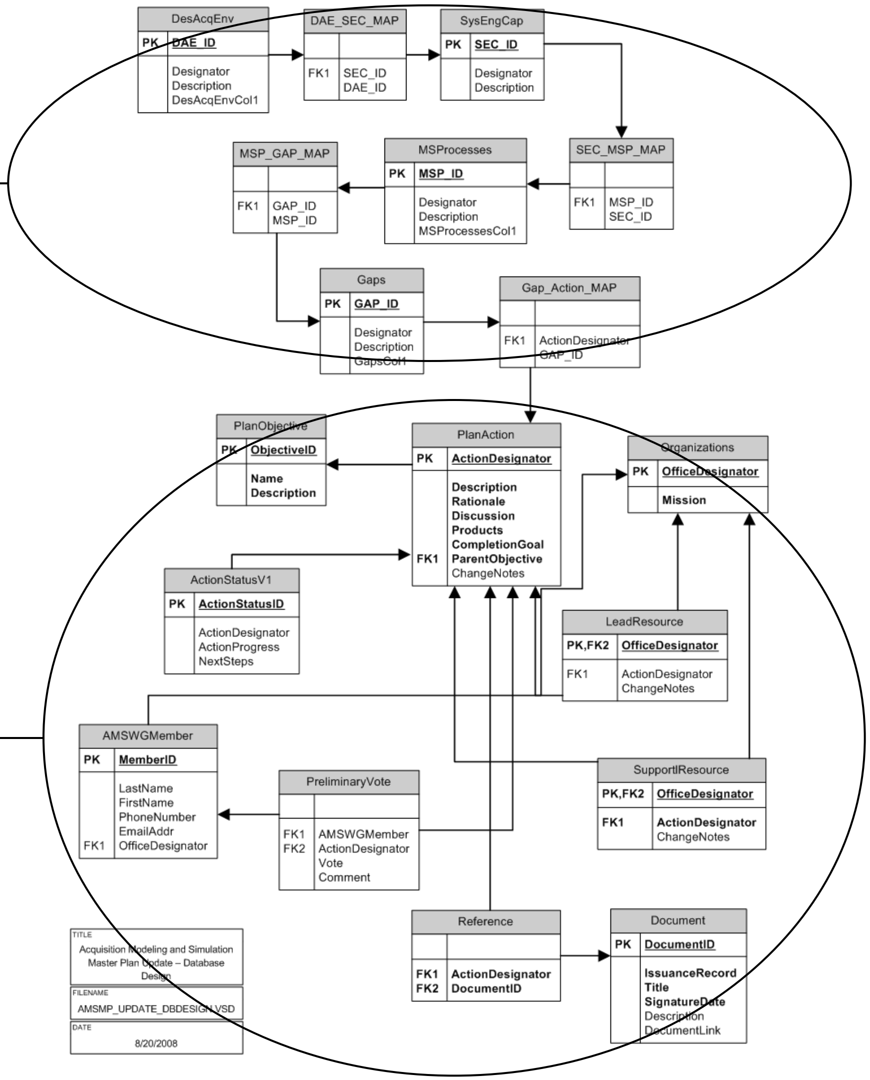
AMSMP Update Database

Systems Engineering Artifacts; Fully Traceable.

Master Plan Contents



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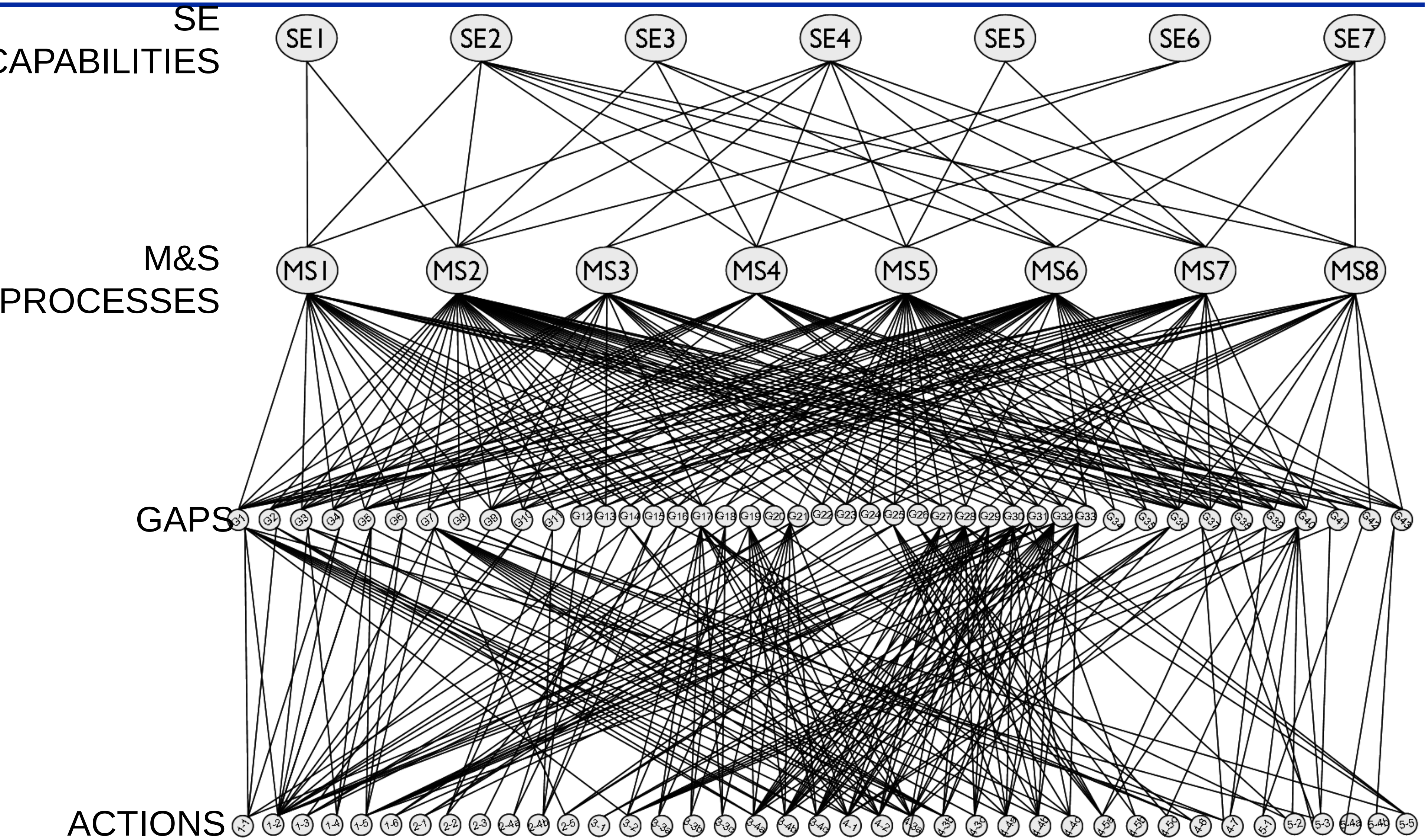
AMSMP Traceability Map



Ogden Air Logistics Center

U.S. AIR FORCE

OGDEN ALC

A-10 Avionics System Architecture Trade Analysis (AVSATA) Program

Jerry Coates
A-10 OSS&E Integrator
OO-ALC/538 ACSG/EN

Richard Sorensen
KIHOMAC Staff Systems Engineer

KIHOMAC
System Acquisition Excellence

Agenda

- A-10 Background
- Architecture & Requirements Overview
- A-10 Architecture Development
- Example
- Path Forward
- Results

A-10 BACKGROUND

Legacy Aircraft
The "Green Machine"

- A-10 designed as a tank buster, low-technology, easy to maintain ground attack fighter
  - A-10 upgrades limited in scope and capability.
  - Sustainment programs
    - Largely form/fit/function replacements.
  - Lack of funding and a master plan (architecture roadmap) resulted in stovepipe sustainment/capabilities modifications without considerations for:
    - Systems Engineering
    - Distribution of functions
    - Growth of capabilities
    - Interoperability

Beyond Design Life

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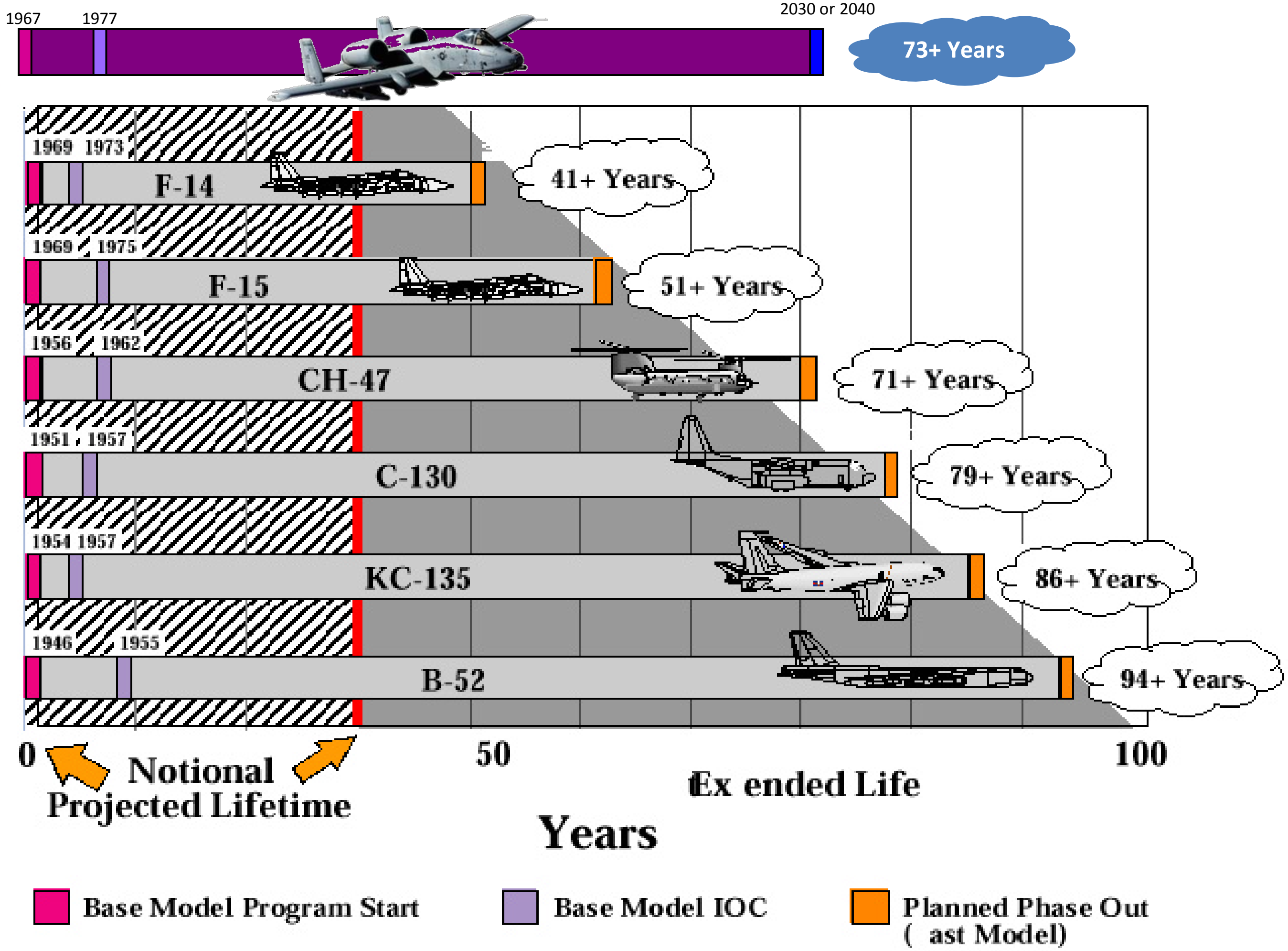

Baseline Graph extracted from *USAF Viable Combat Avionics Initiative Implementation*, Mr. Doug Ebersole; AFMC Aeronautical Enterprise Program Office; 22 Oct 02; pg 5

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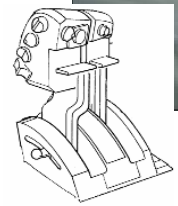
Precision Engagement
This Ain't Your Daddy's Hog

A-10A



New Right Throttle Grip

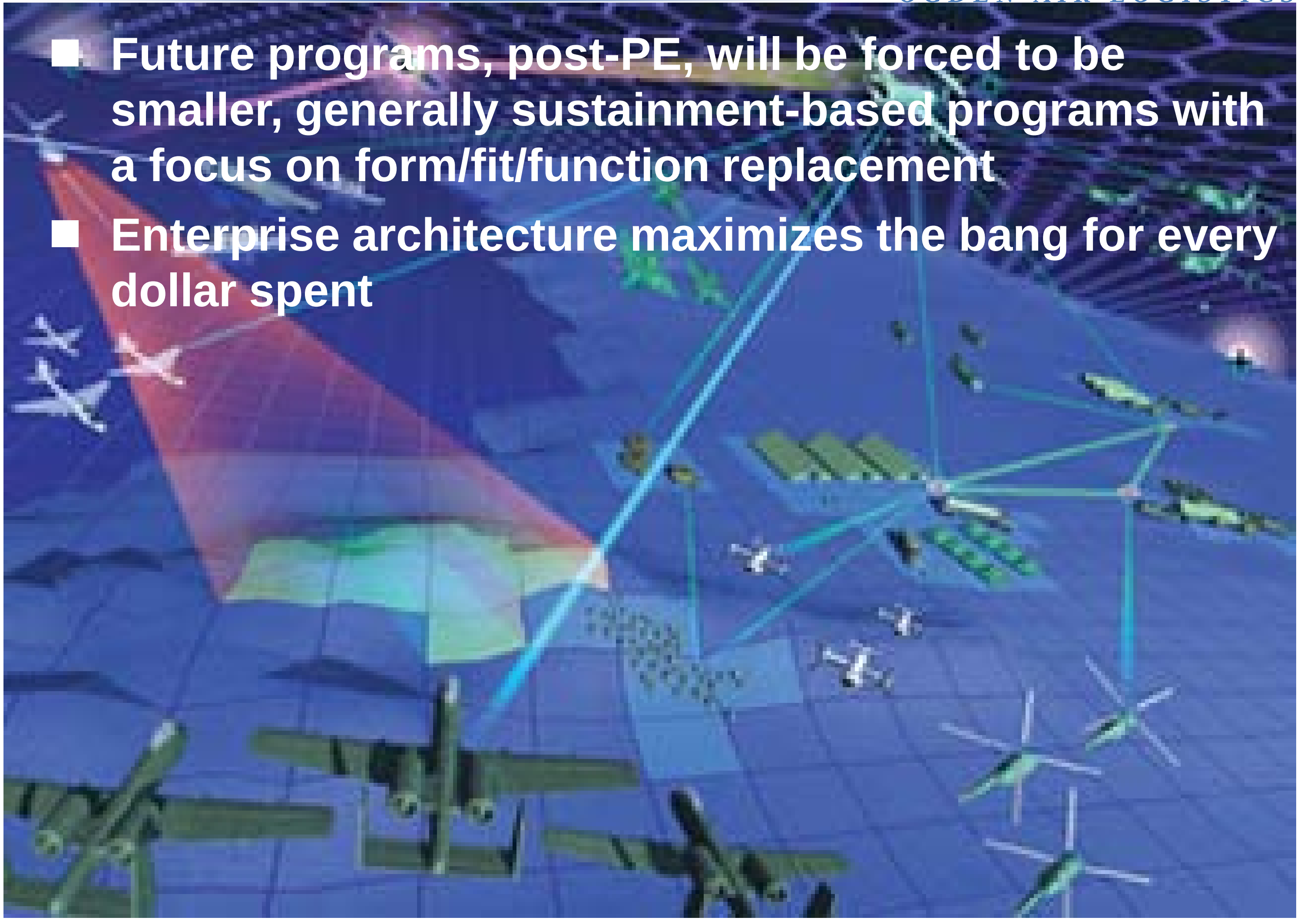
A-10C

- Precision Engagement is the largest upgrade in the history of A-10
  - Significantly upgraded and changed the platform, providing an integrated avionics suite with a considerable number of functions moved into software
  - New aircraft baseline provides a point of departure for many new operational and sustainment capabilities

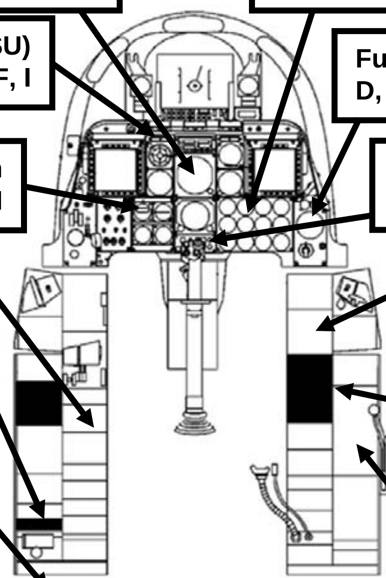
A-10 2030

"To Infinity and Beyond…"

- Future programs, post-PE, will be forced to be smaller, generally sustainment-based programs with a focus on form/fit/function replacement
- Enterprise architecture maximizes the bang for every dollar spent



Avionics Sustainment Program (ASP) (Wish List)



Flight Instruments – D, R, M, O, P, I

Engine Instruments – D, R, M, O, I

Replace w/ MFCD

ALR-69/ALQ-213 (addressed in EWSU) – D, R, M, O, P, G, F, I

Replace w/ upgraded RWR

Fuel Quantity ID – D, R, M, O, P, G, I

Replace w/ software

Heading & Attitude Reference System – D, R, M, O, P, G, F, I

Replace w/ COTS B/U instrument

Nav Mode Select Panel – D, R, M, O, P, G, I

Replace w/ software

Communication/Navigation – R, M, P, G, I

Integrate with OFP

Caution Annunciator Panel – D, R, M, O, P, G, F, I

Replace w/ software

Intercom Panel – D, R, M, O, P, G, F, I

Replace w/ software

Control Display Unit – D, R, M, O, P, G, F

Replace

Data Transfer System – D, O, P, G, F

Upgrade/Consolidate

Digital Video and Data Recorder – D, R, M, O, P, G, F, I

Upgrade/Consolidate

Key
- D – Diminishing Manufacturing Sources & Material Shortages Issues
- R – Reliability Issues
- M – Maintainability Issues
- O- Obsolescence issues
- P – Performance Issues (Operations)
- G – Growth Issues
- F- Function is duplicated elsewhere
- I – Not integrated

Out of Cockpit systems

System	Issues	Action
Stall Warning System	D, R, M, O, P, G, F	*Replace w/ software*
Embedded GPS/INS	R, M, P, G	*Update*
Data Distribution	none	*Develop/Integrate*
TEMS/ADR	P, G, F	*Upgrade/Integrate*
Radar Altimeter	R, M, P, G	*Replace*

A-10 AVSATA Vision

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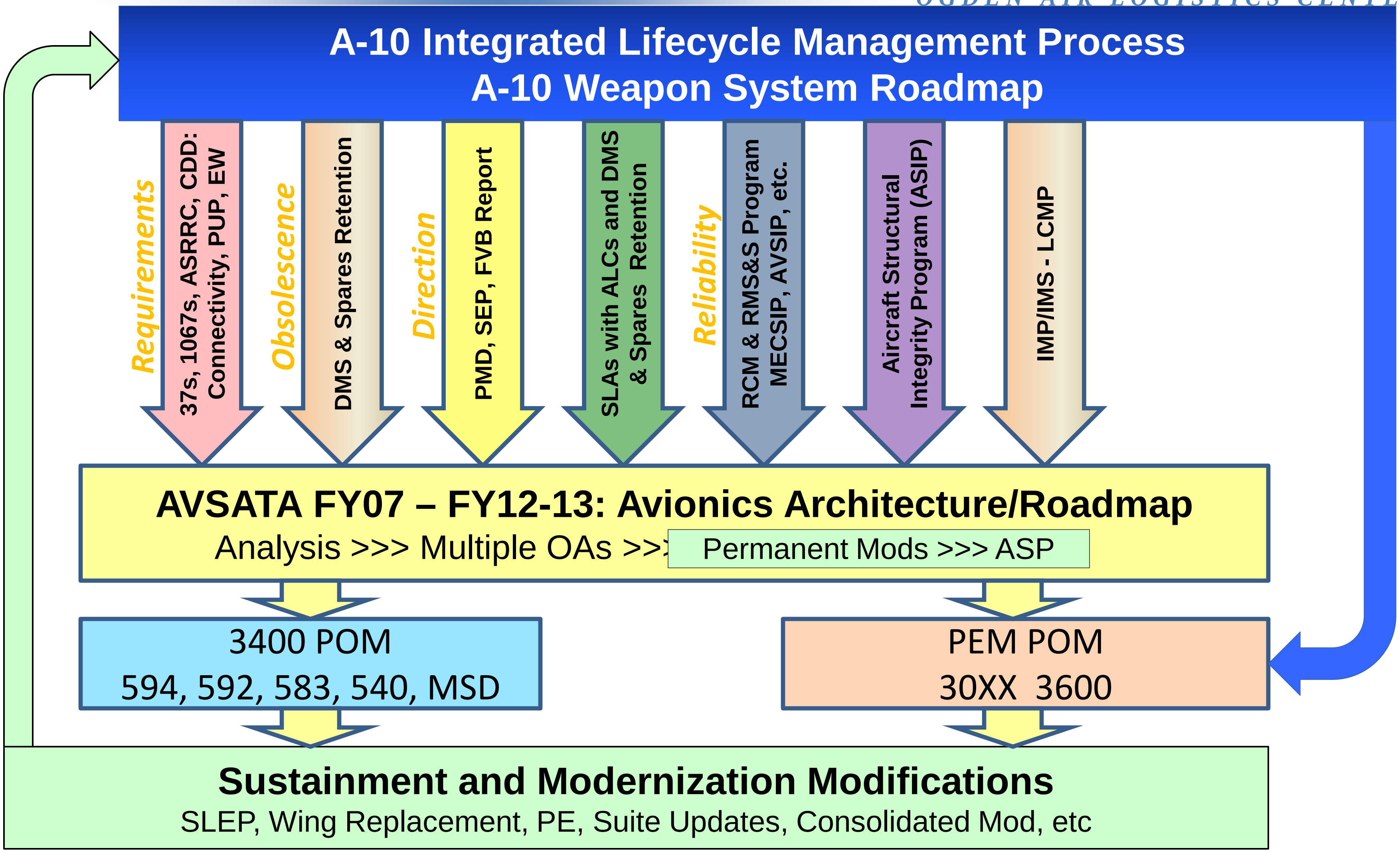


A-10 Integrated Architecture

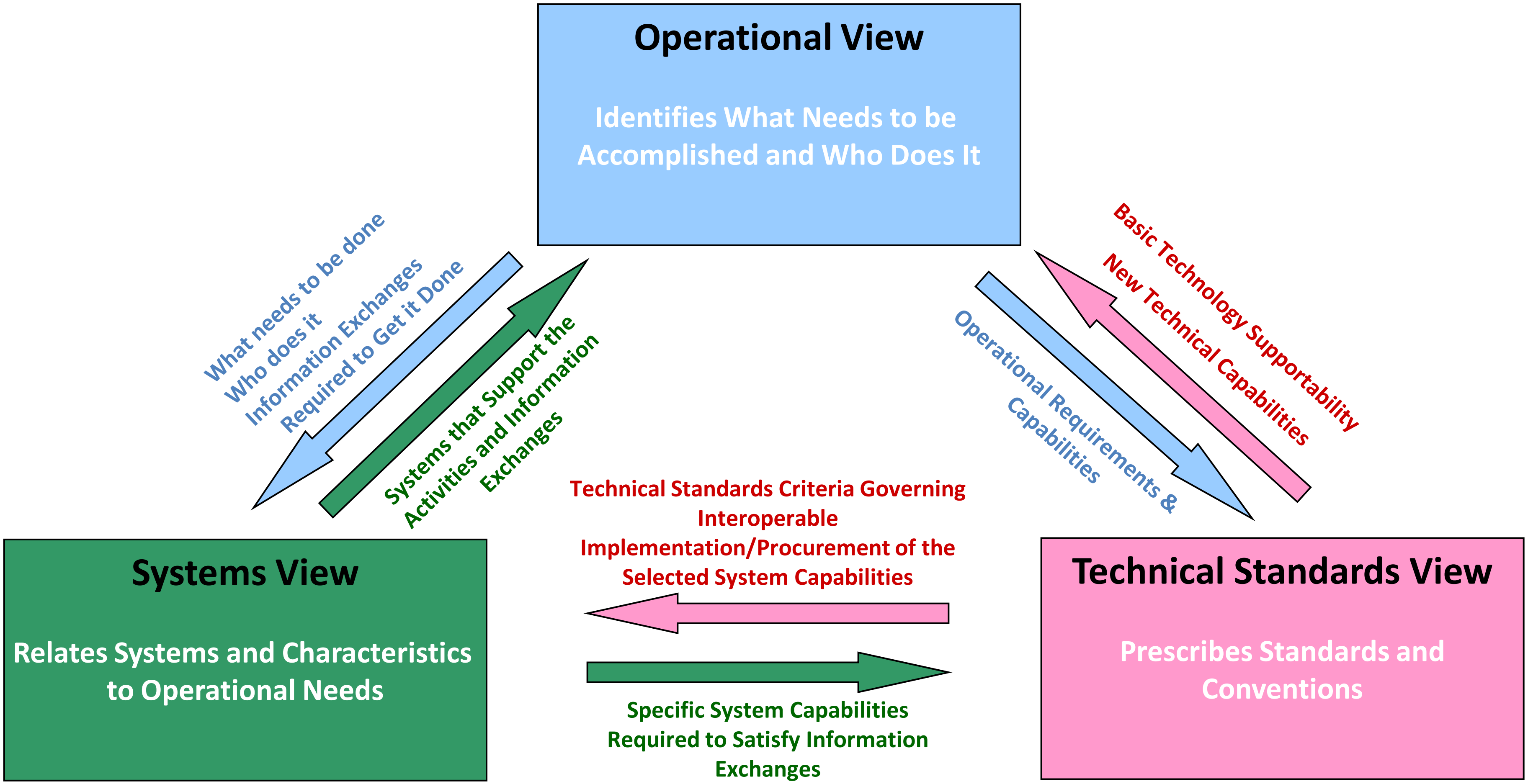
- AVSATA provides the framework to help make the most of the resource limited sustainment programs
- Integrated architecture provides a comprehensive plan for the operational and technical capabilities and interconnections required by the aircraft lifecycle sustainment
  - Defines a roadmap to show smaller programs how they can fit into the overall plan
  - Defines a way to leverage small sustainment investments into significant increased platform sustainment and capability
- ***Path Finding*** process applied to legacy sustainment
  - Keep A-10 relevant in our nations conflict and at the forefront of the force throughout its lifecycle.

ARCHITECTURE & REQUIREMENTS OVERVIEW

Integrated Architecture Overview

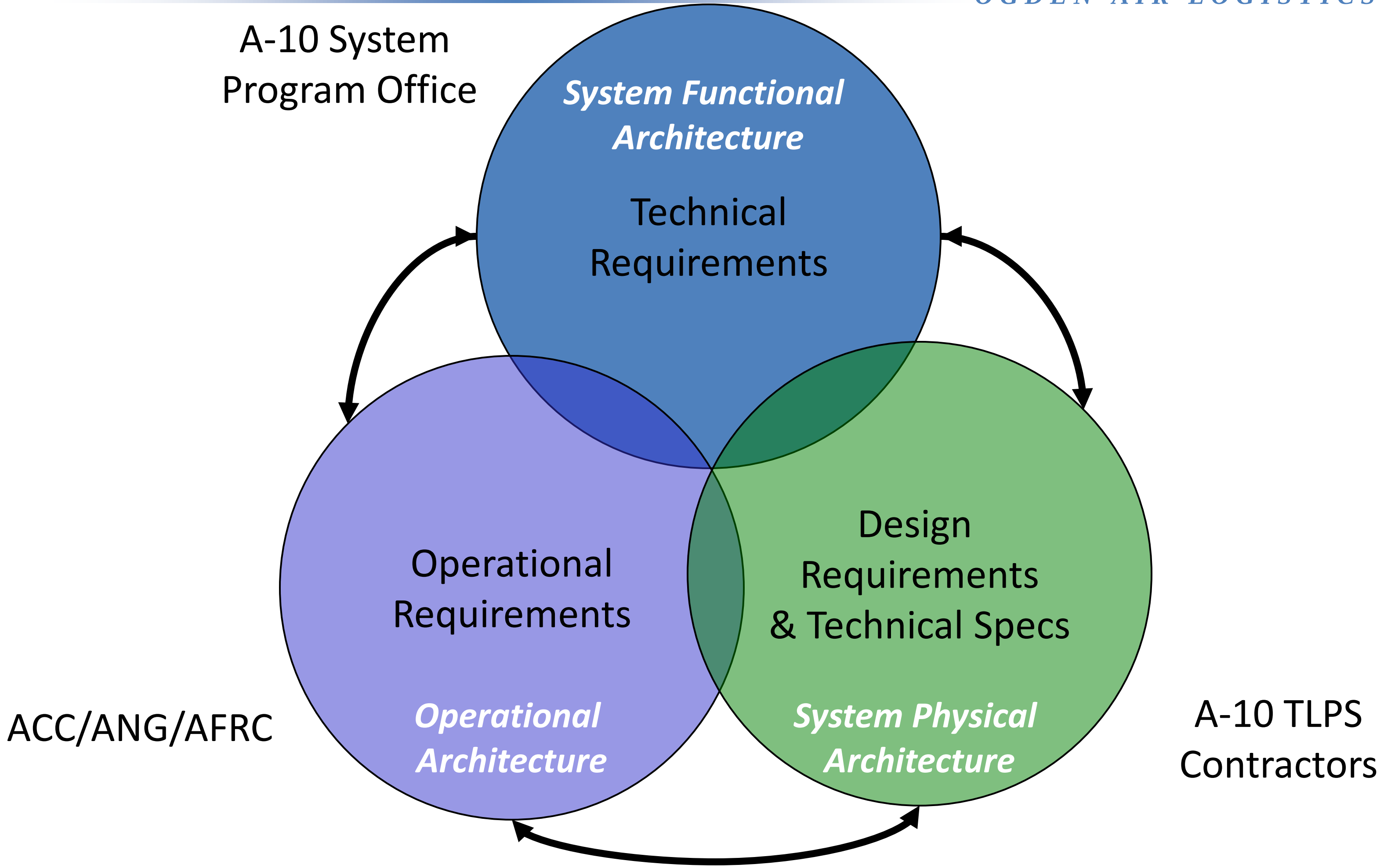
- **What is an architecture?**
  - “The structure of components, their relationships, and the principles and guidelines governing their design and evolution over time” – DoD Integrated Architecture Panel
- **What is an “integrated” architecture?**
  - Architecture is an integrated architecture when products and their constituent architecture data elements are developed such that architecture data elements defined in one view are the same (i.e., same names, definitions, and values) as architecture data elements referenced in another view.
- **What are the advantages of integrated architectures?**
  - Facilitate an organized and consistent standardized design process
  - Facilitate the clear definition and implementation of new operational, system & technical requirements
  - Promote interoperability
  - *Required* by Joint Capabilities Integration & Development System (JCIDS)!
  - Provide for traceability of system requirements back to the originating joint concepts (facilitates successful POM inputs, i.e., getting program funding)
  - **Facilitate systems and systems sustainment engineering**

Fundamental Linkages Between Views



Traceability of Requirements

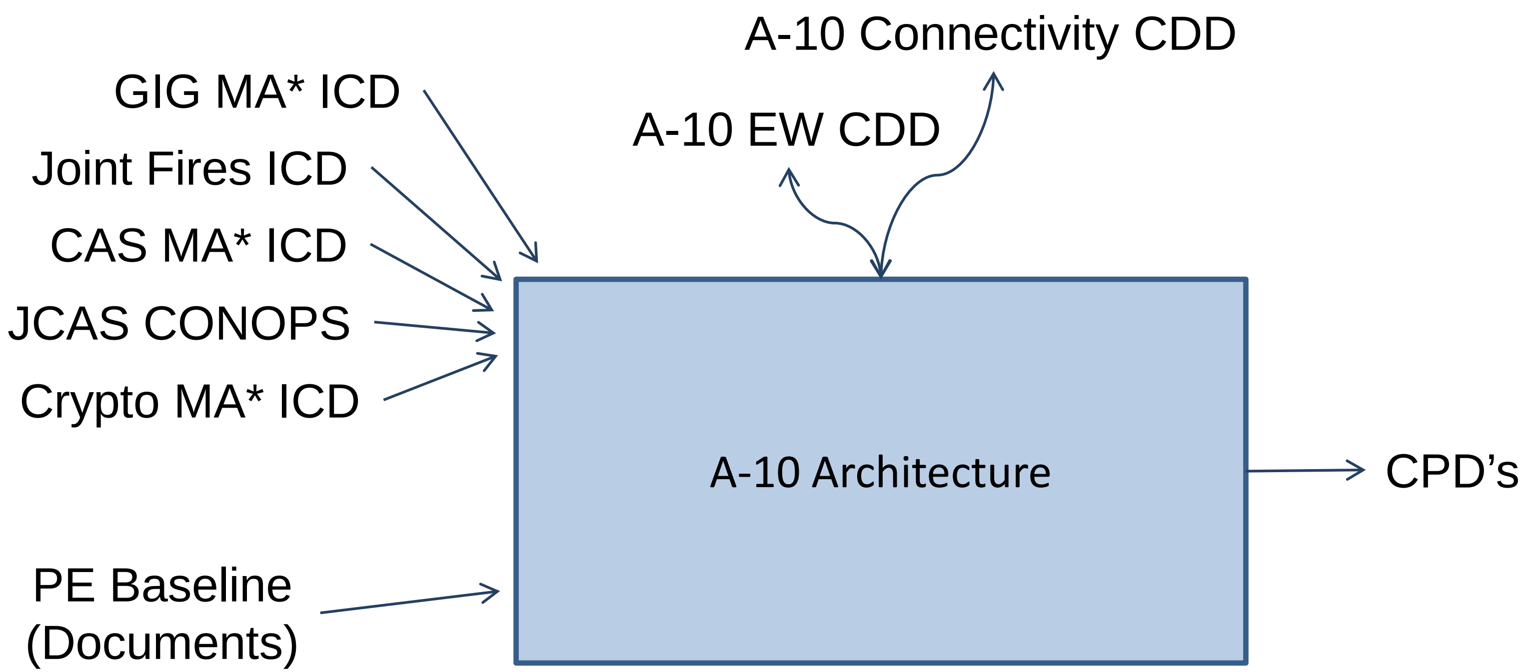
from Users to Acquirers to Contractors



Requirements are tightly coupled to Architectures

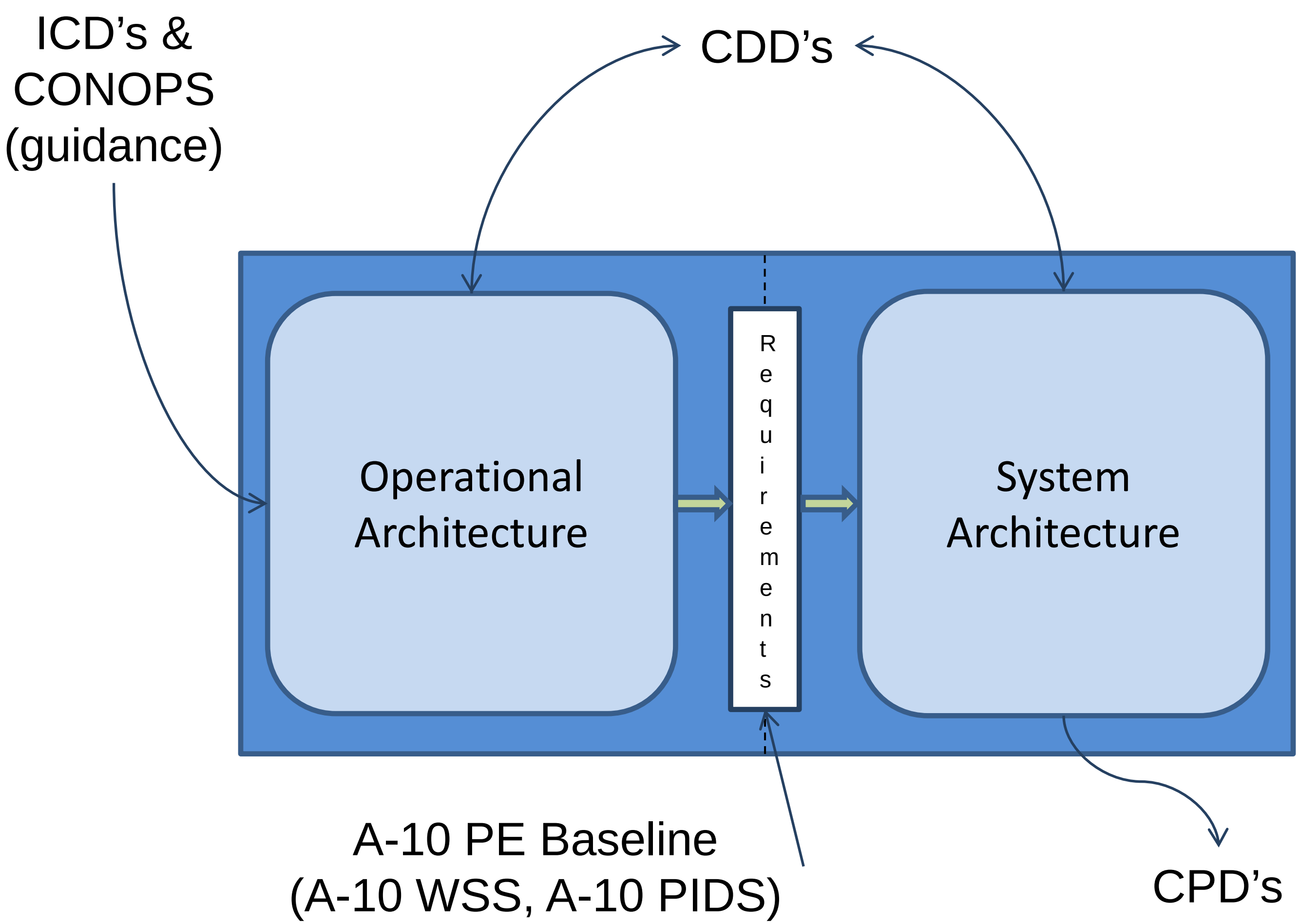
A-10 ARCHITECTURE DEVELOPMENT

A-10 Architecture and External Docs

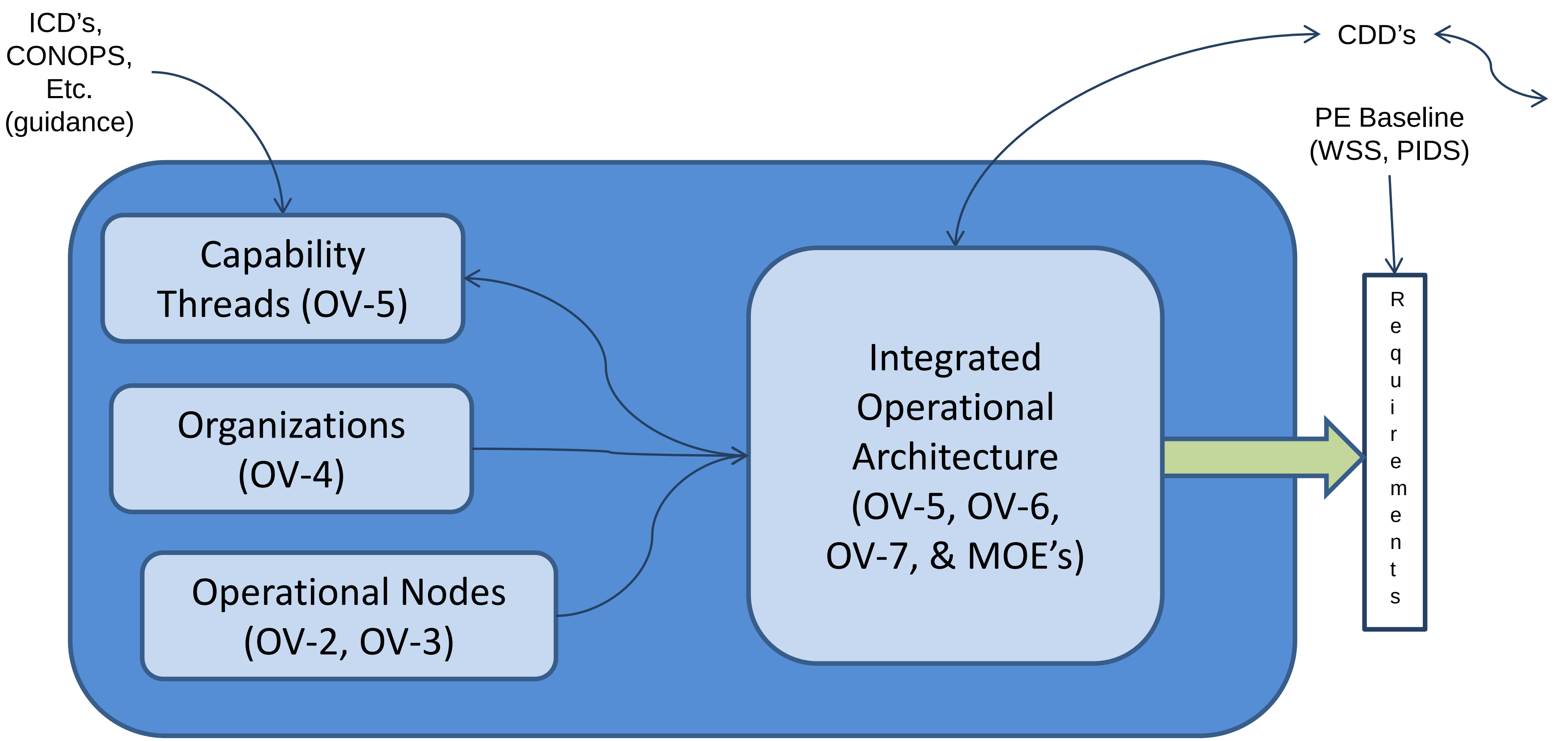


* MA ICD's were directed to be converted or they were rescinded effective June 2008

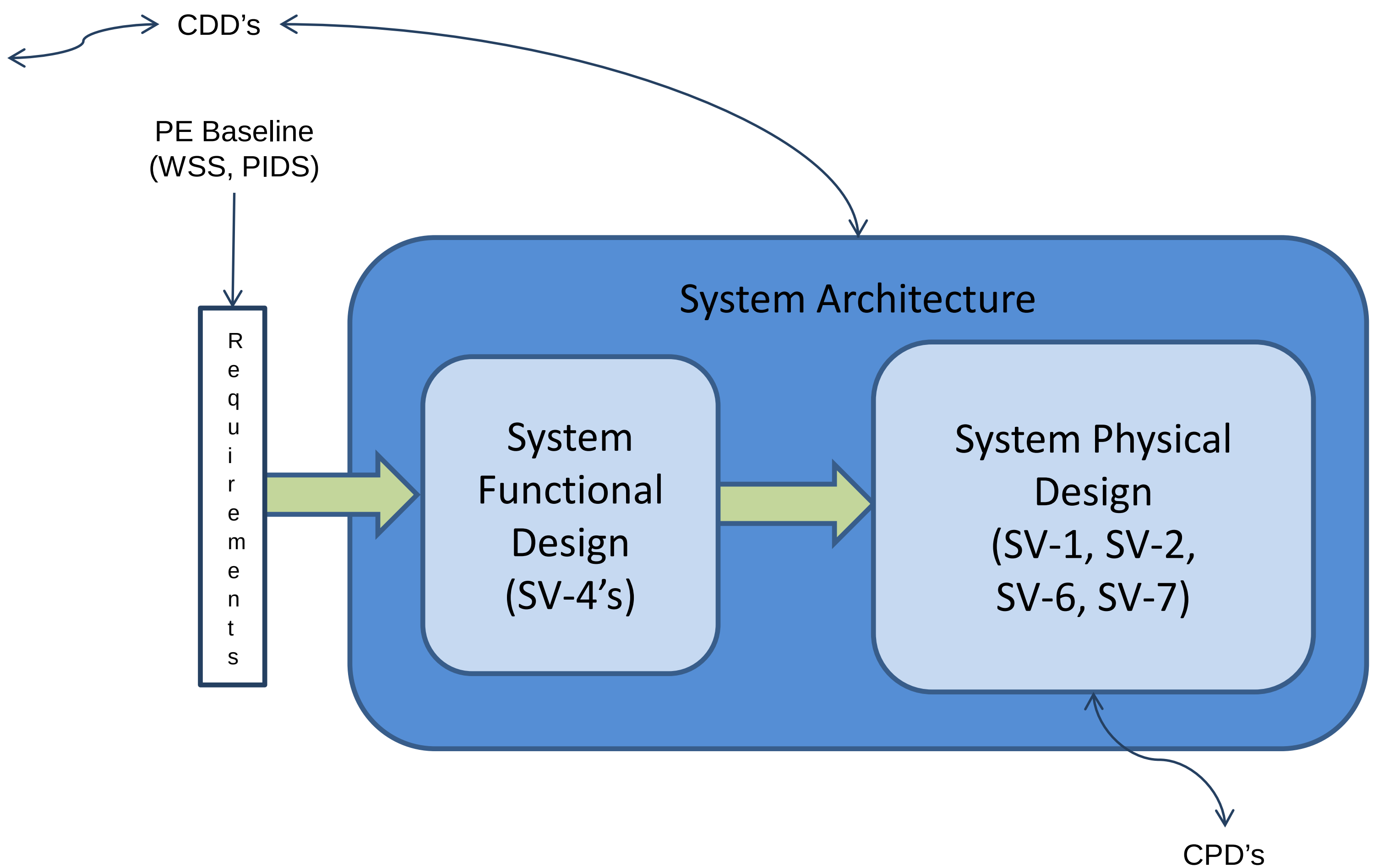
Architecture
-Top-Level View



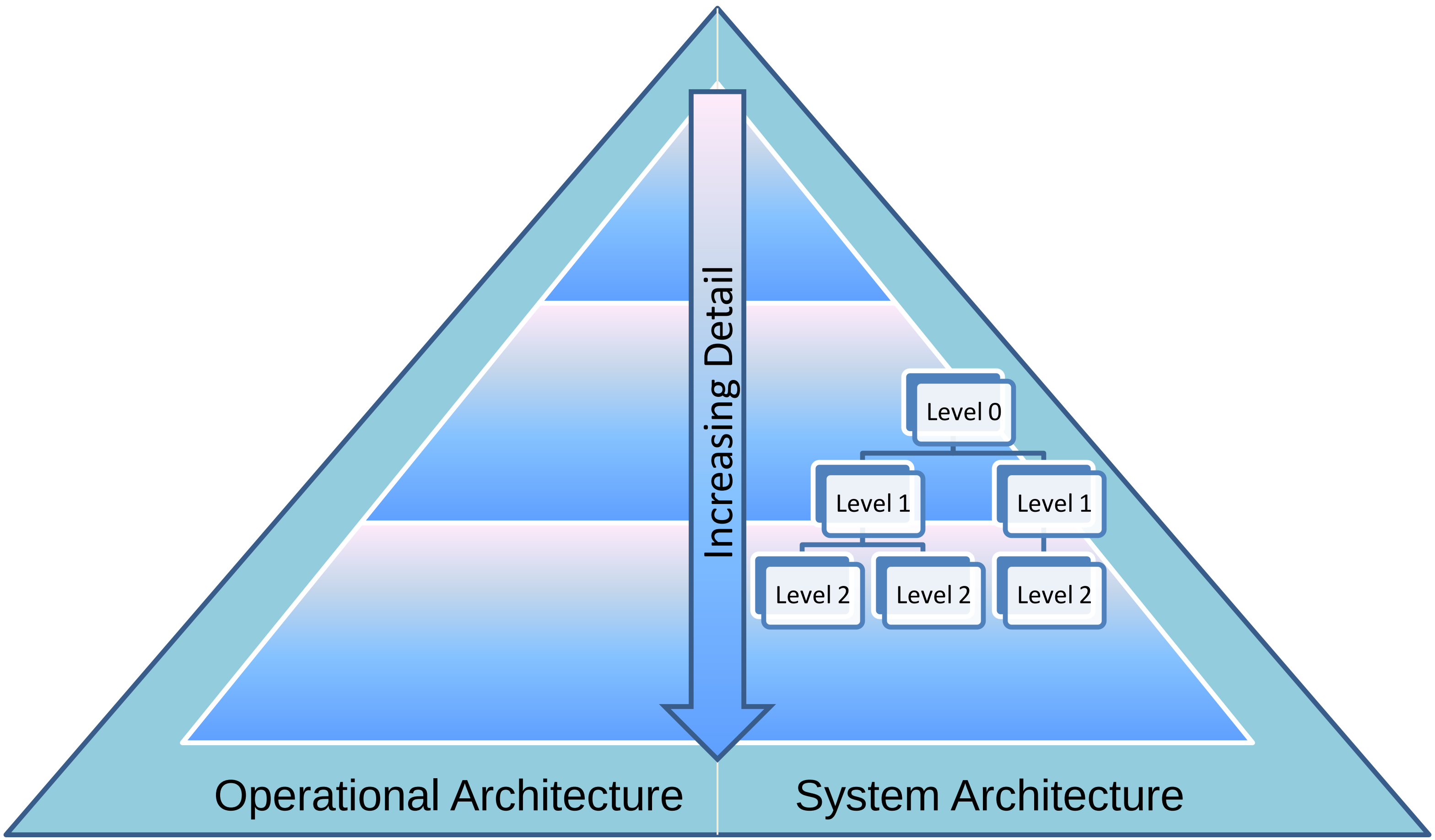
Operational Architecture



System Architecture



Architecture Layering



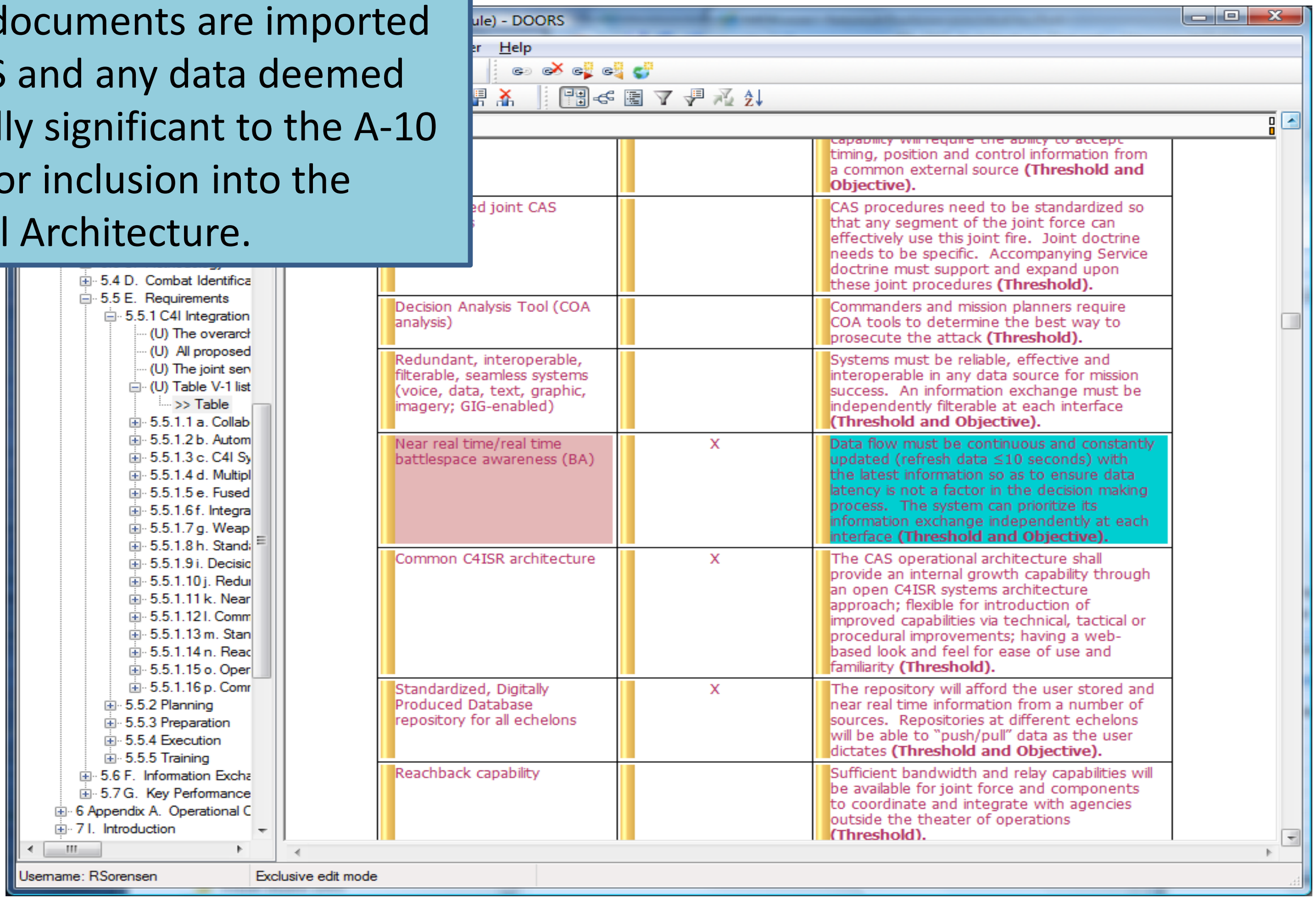
EXAMPLE

From JCAS CONOPS:

- Establish & Maintain Battlespace Awareness

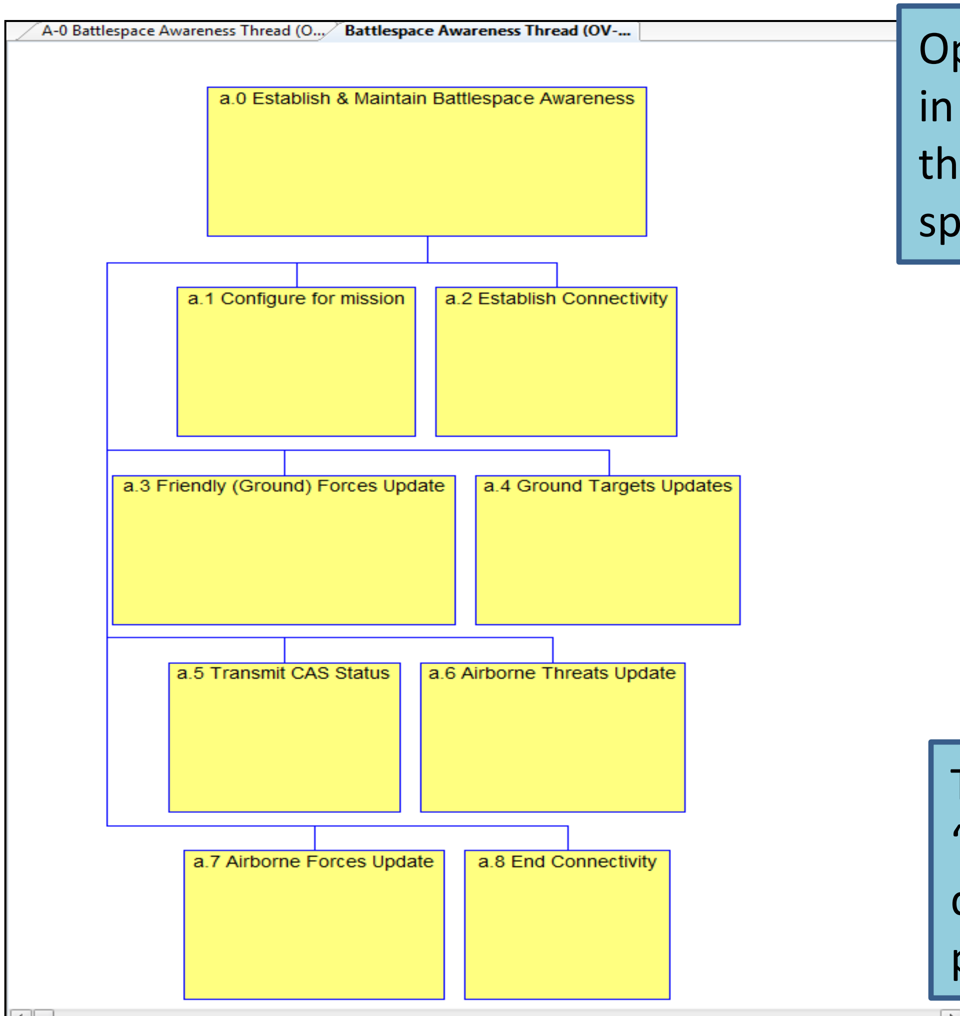
JCAS CONOPS in DOORS

Joint level documents are imported into DOORS and any data deemed operationally significant to the A-10 is marked for inclusion into the Operational Architecture.



Operational Architecture Hierarchy

- Establish & Maintain Battlespace Awareness



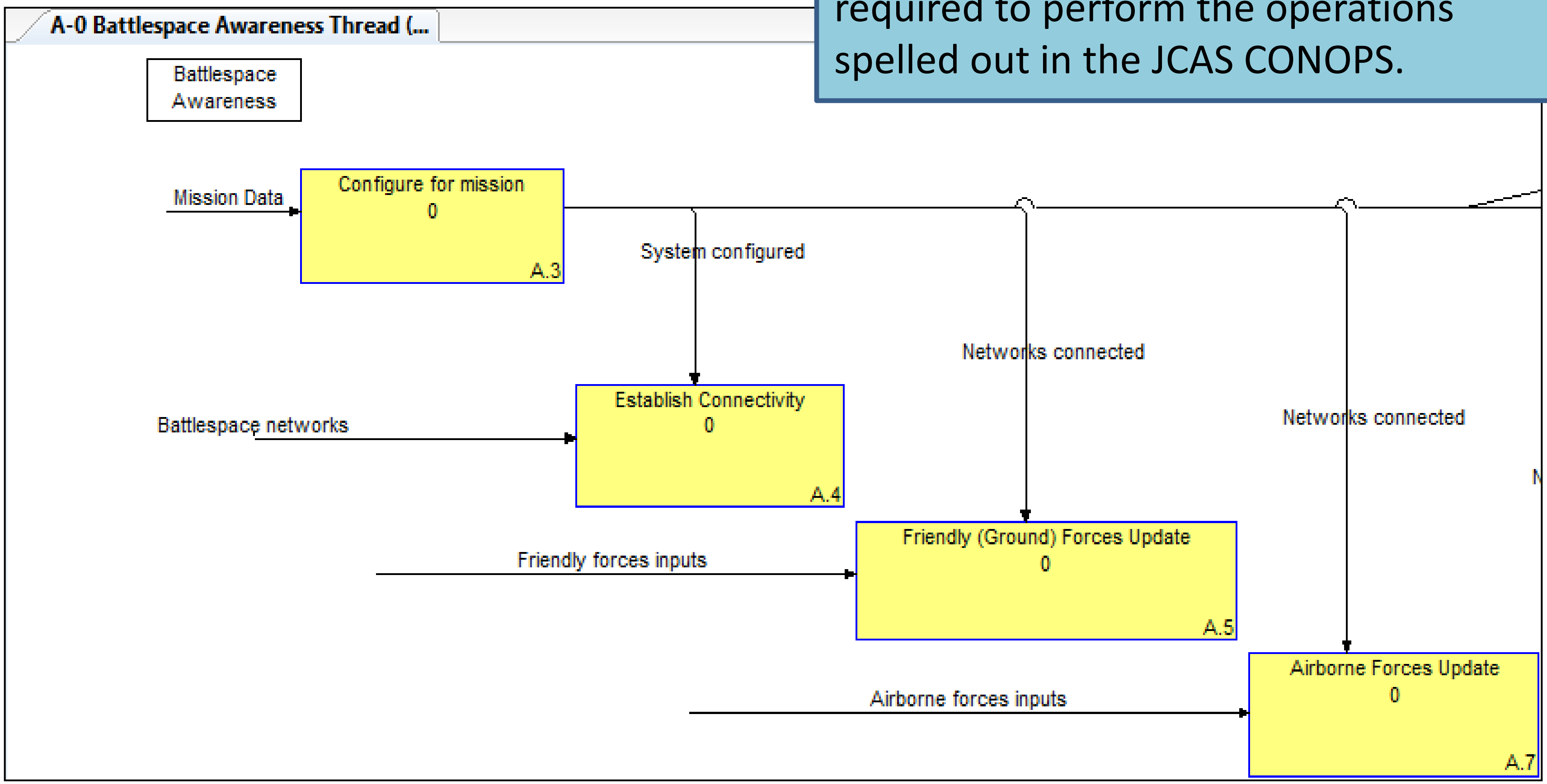
Operational Architectures are created in System Architect and linked both to the Joint Level capabilities and the A-10 specific system requirements.

This example shows the JCAS CONOPS 'Battlespace Awareness' capability decomposed into the components that provide the capability.

Operational Architecture Thread

- Establish & Maintain Battlespace Awareness

This view (OV-5) details the general data required to perform the operations spelled out in the JCAS CONOPS.



Operational Requirements

- Derived from Operational Architecture

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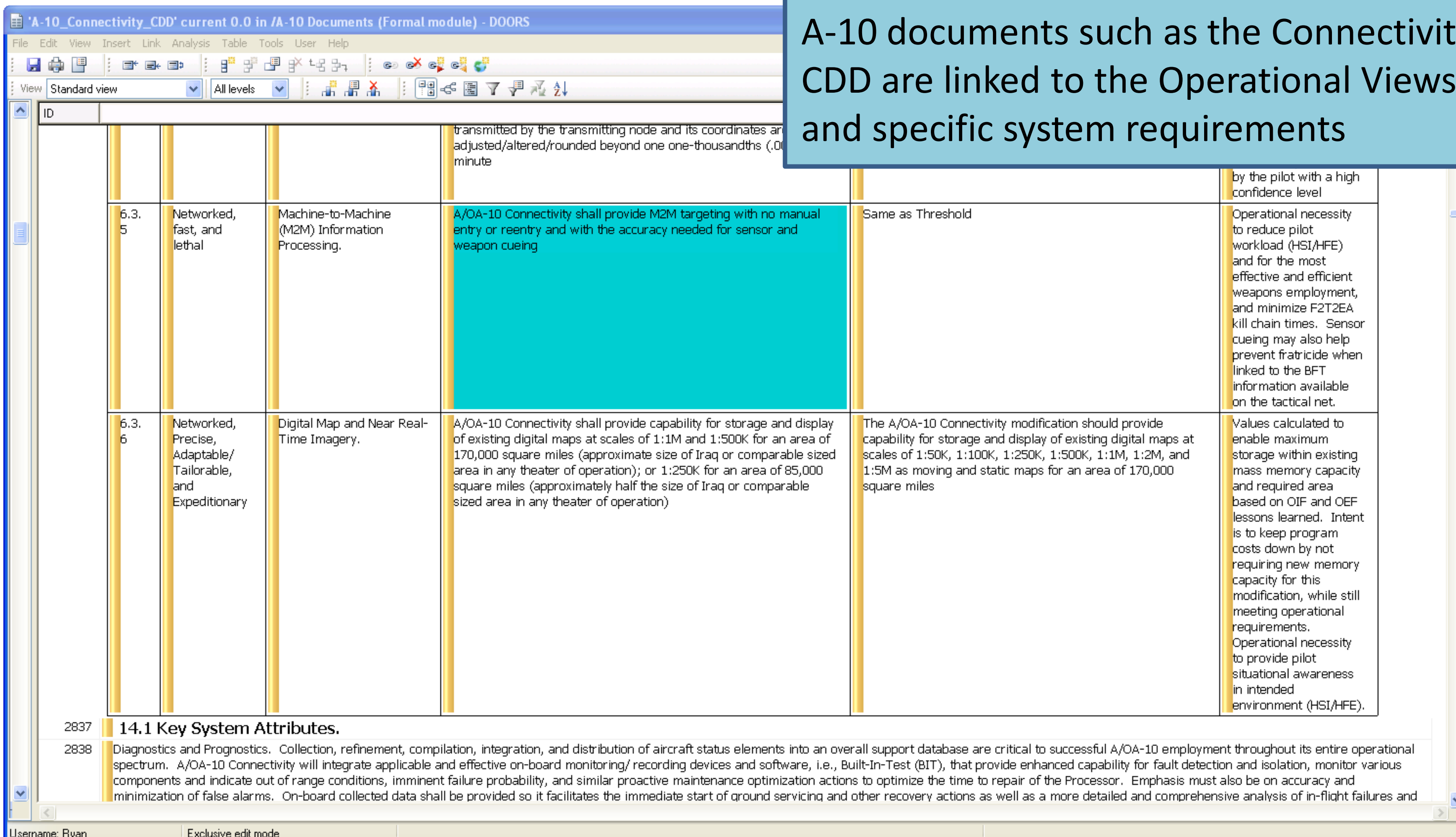
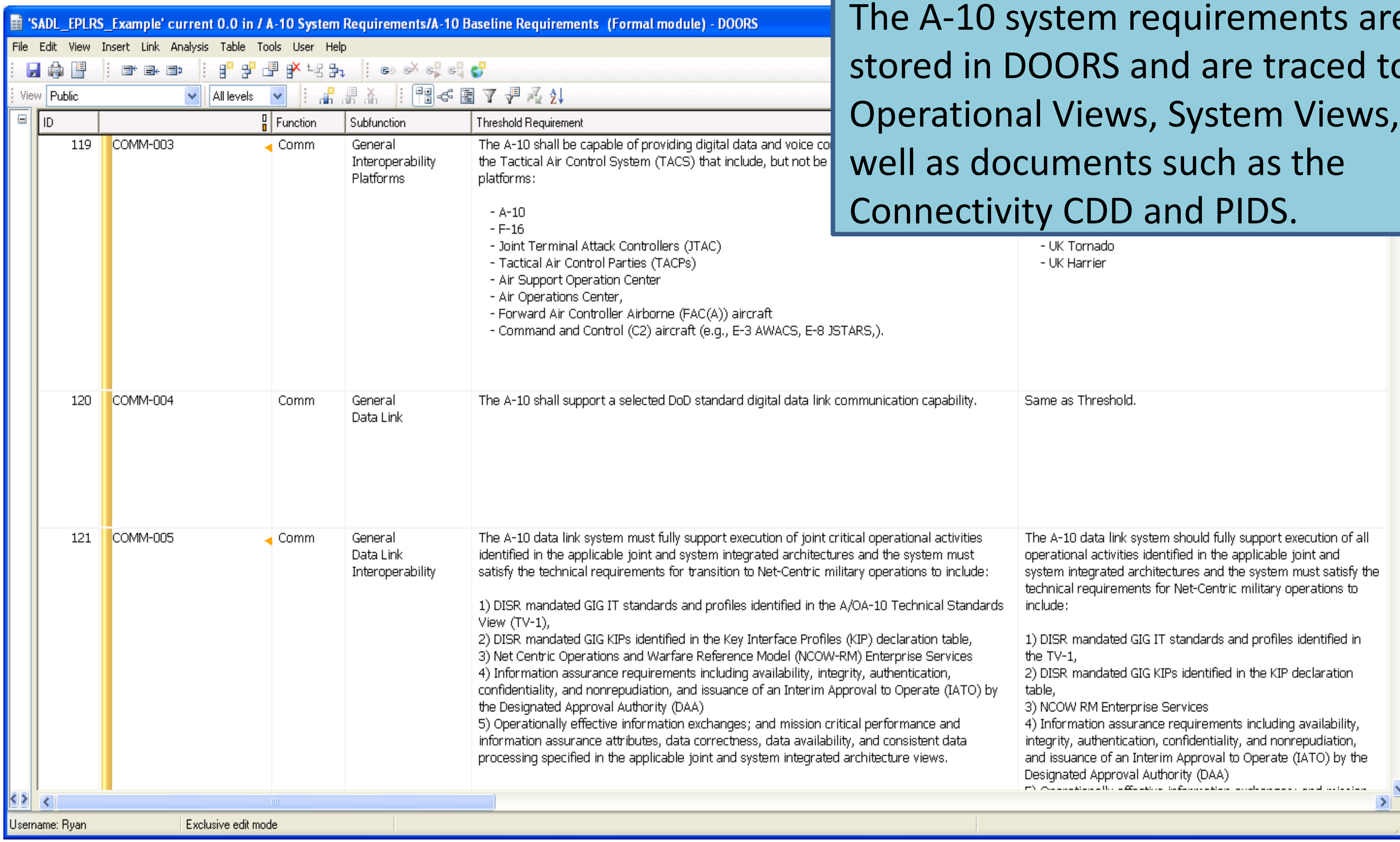
A-10 documents such as the Connectivity CDD are linked to the Operational Views and specific system requirements



System Requirements

- Derived from Operational Requirements

The A-10 system requirements are stored in DOORS and are traced to the Operational Views, System Views, as well as documents such as the Connectivity CDD and PIDS.



ID		Function	Subfunction	Threshold Requirement	
119	COMM-003	Comm	General Interoperability Platforms	The A-10 shall be capable of providing digital data and voice co the Tactical Air Control System (TACS) that include, but not be platforms: - A-10 - F-16 - Joint Terminal Attack Controllers (JTAC) - Tactical Air Control Parties (TACPs) - Air Support Operation Center - Air Operations Center, - Forward Air Controller Airborne (FAC(A)) aircraft - Command and Control (C2) aircraft (e.g., E-3 AWACS, E-8 JSTARS,).	- UK Tornado - UK Harrier
120	COMM-004	Comm	General Data Link	The A-10 shall support a selected DoD standard digital data link communication capability.	Same as Threshold.
121	COMM-005	Comm	General Data Link Interoperability	The A-10 data link system must fully support execution of joint critical operational activities identified in the applicable joint and system integrated architectures and the system must satisfy the technical requirements for transition to Net-Centric military operations to include: 1) DISR mandated GIG IT standards and profiles identified in the A/OA-10 Technical Standards View (TV-1), 2) DISR mandated GIG KIPs identified in the Key Interface Profiles (KIP) declaration table, 3) Net Centric Operations and Warfare Reference Model (NCOW-RM) Enterprise Services 4) Information assurance requirements including availability, integrity, authentication, confidentiality, and nonrepudiation, and issuance of an Interim Approval to Operate (IATO) by the Designated Approval Authority (DAA) 5) Operationally effective information exchanges; and mission critical performance and information assurance attributes, data correctness, data availability, and consistent data processing specified in the applicable joint and system integrated architecture views.	The A-10 data link system should fully support execution of all operational activities identified in the applicable joint and system integrated architectures and the system must satisfy the technical requirements for Net-Centric military operations to include: 1) DISR mandated GIG IT standards and profiles identified in the TV-1, 2) DISR mandated GIG KIPs identified in the KIP declaration table, 3) NCOW RM Enterprise Services 4) Information assurance requirements including availability, integrity, authentication, confidentiality, and nonrepudiation, and issuance of an Interim Approval to Operate (IATO) by the Designated Approval Authority (DAA)

System Functional Architecture

- Developed from System Requirements

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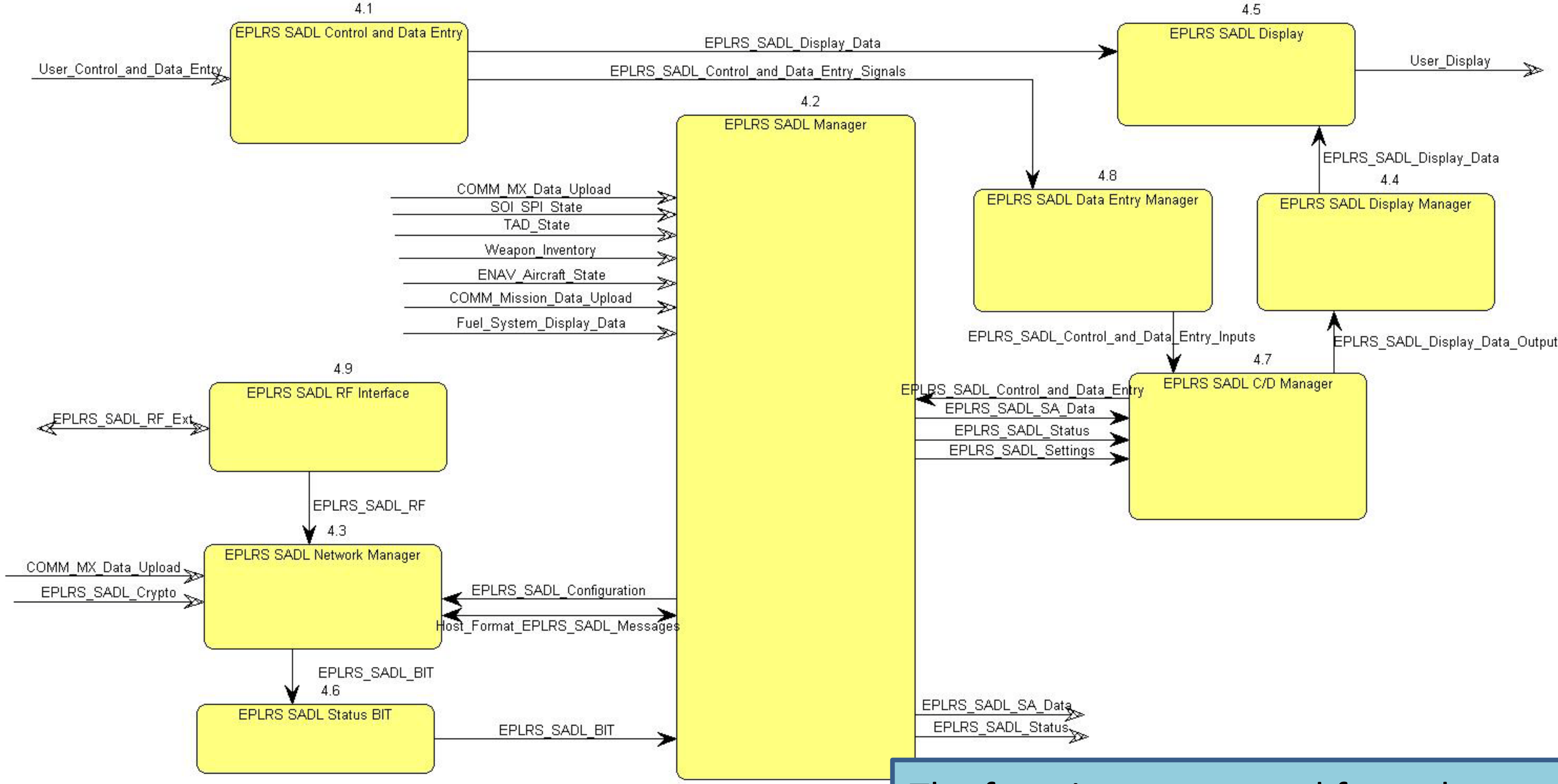

The functions are traced from the system requirements which they fulfill as well as any associated Operational Views.

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System Physical Architecture

- Implements System Functional Architecture

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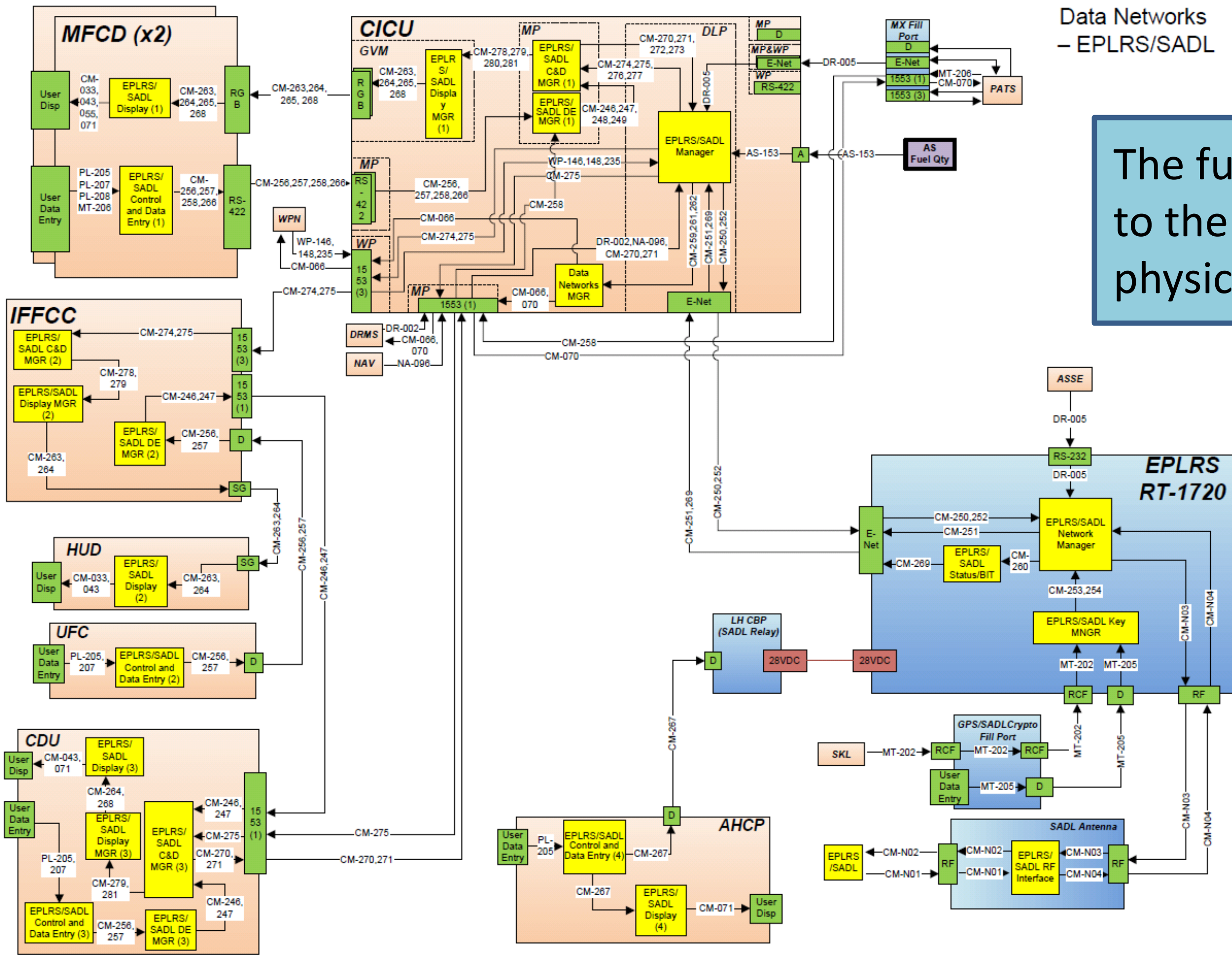
Data Networks
– EPLRS/SADL



The functions are then linked to the actual systems in the physical architecture.

Ref: A-10 System Architecture Plan Rev A, Vol II

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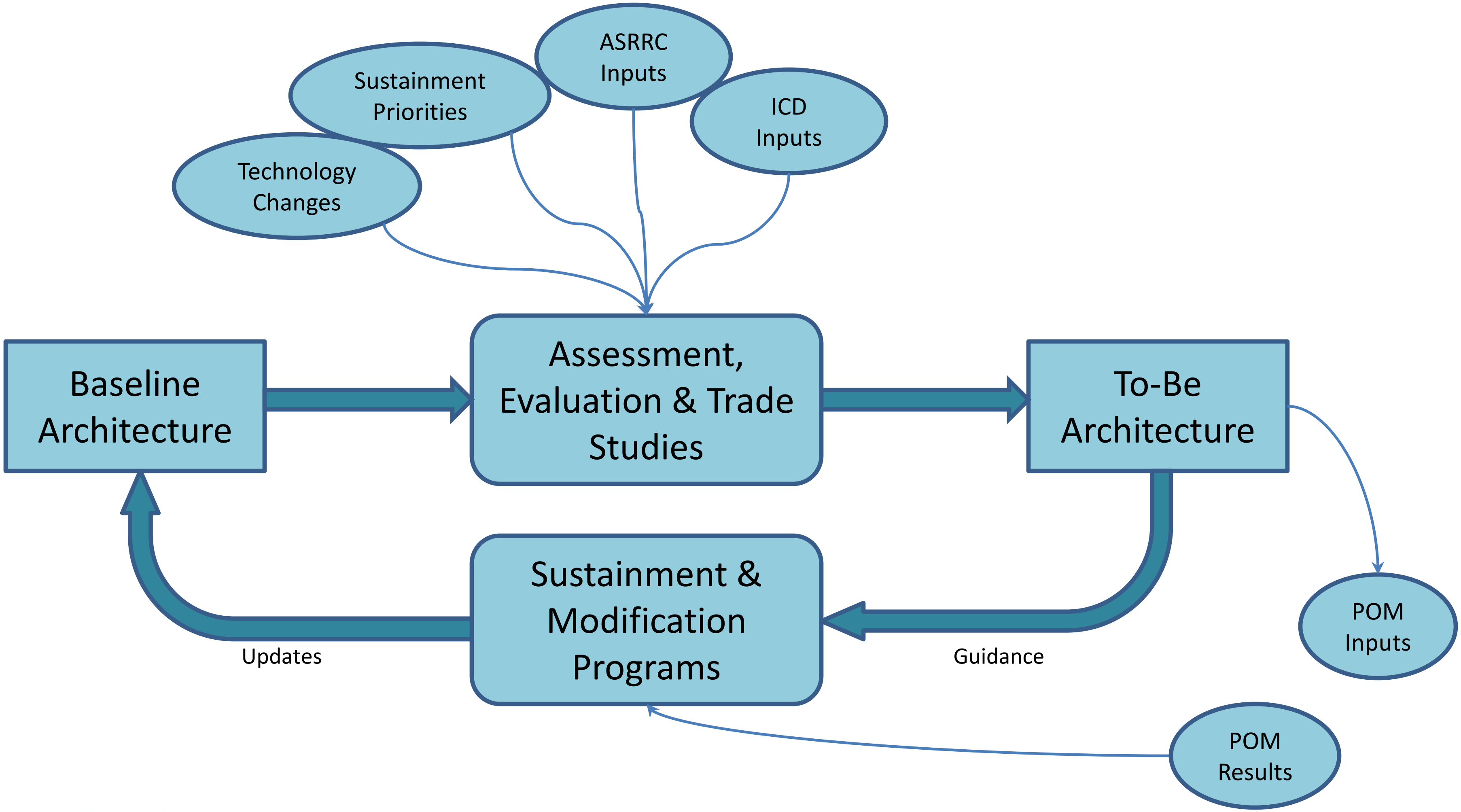
PATH FORWARD

Roadmap Process



Notional SV-8

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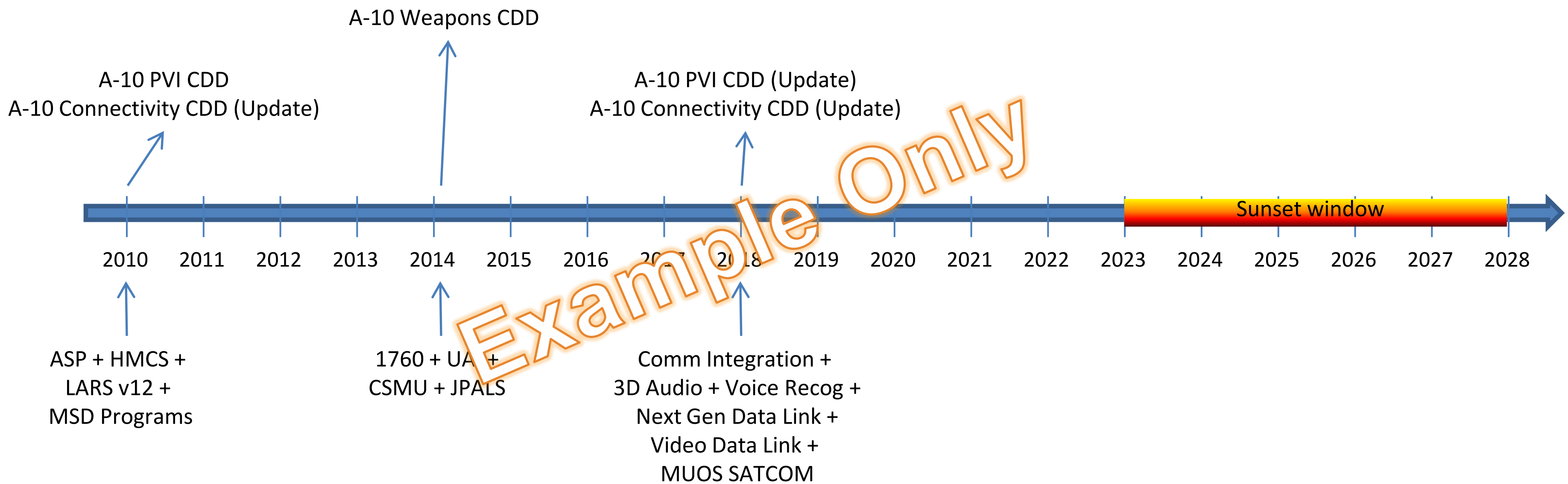
Systems/Services Evolution



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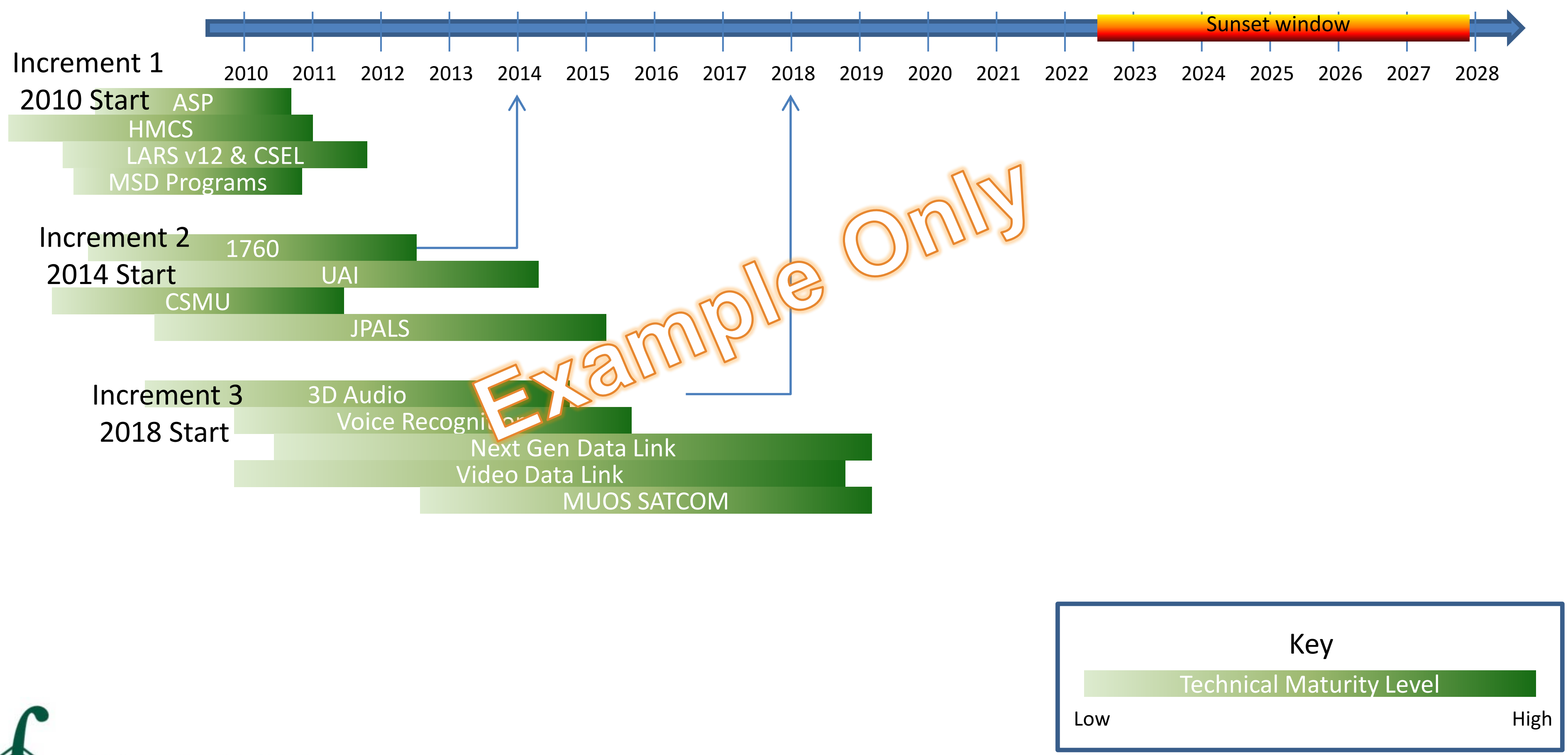
Notional SV-9

Technology Forecast



RESULTS

AVSATA Results

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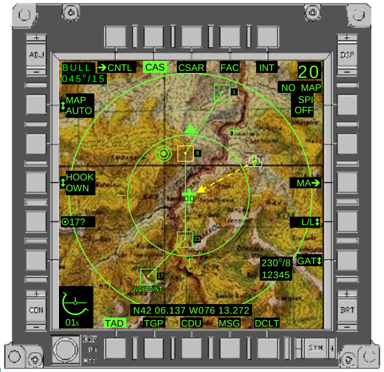
- AVSATA already resulted in integrated system on A-10
  - Distributed mass memory (greater map and data storage),
  - Helmet mounted cueing,
  - LARS V12, Integrated personnel recovery systems for use during CSAR,
  - Expanded bus infrastructure to support future high speed devices (12 Port 1GB Ethernet switch)



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Tying Requirements to Funding Requests

(U) A- 10Avionics Sustainment Program (ASP)

BACKGROUND:

(U) A-10 avionics system has aging Line Replaceable Units (LRU) that have exceeded their design lives. The reliability, sustainment, and obsolescence issues are decreasing aircraft availability, increasing maintenance costs, and limiting growth, mission readiness and capability.

ADJUSTMENT:

(U) Develop, procure, and install 344 ASP kits on A-10 fleet (replace 26 aging LRUs inclu[illegible]g [illegible]e displays, high maintenance drivers with obsolescence issues with 5 new LRUs per [illegible]ft)

$M: XXXXXXXXXX	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17
ADJUSTMENT			18.25	[illegible]	39.7[illegible]	48.51	48.92	26.43
REV PGM TOTAL			[illegible]	40.[illegible]	39.78	48.51	48.92	26.43

PROCUREMENT	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17
ASP				18[illegible]	69	10[illegible]	1[illegible]	50
ADJ				[illegible]8.2[illegible]	40.83	48.51	48.93	26.43
REV								

MPWR	FY12	FY13	FY14	FY15	FY16	FY17
OFF	0	0	0	0	0	0
ENL	0	0	0	0	0	0
CIV	0	0	0	0	0	0

IMPACTS:

-(U) RQMT[illegible] ORD, Dec 04; A-10 EW CDD, A-10 Connectivity CDD, Mar 07, JCAS MA ICD, Jun 04, JCAS CONOPS, Jun 08, Joint Fires ICD, Nov 02, GIG MA Nov 02

- (U) If not funded, Continued decrease in Aircraft Availability
- (U) If not funded, Grounding of aircraft due to unsupportable CDU, HARS, and displays in FY14-FY17
- (U) If not funded, Mission non capable -no (processing) growth path as processors are maxed out, FY17
- (U) If not funded, Projections lead to capability gaps, FY17 through FY28

Systems and Systems Sustaining Engineering

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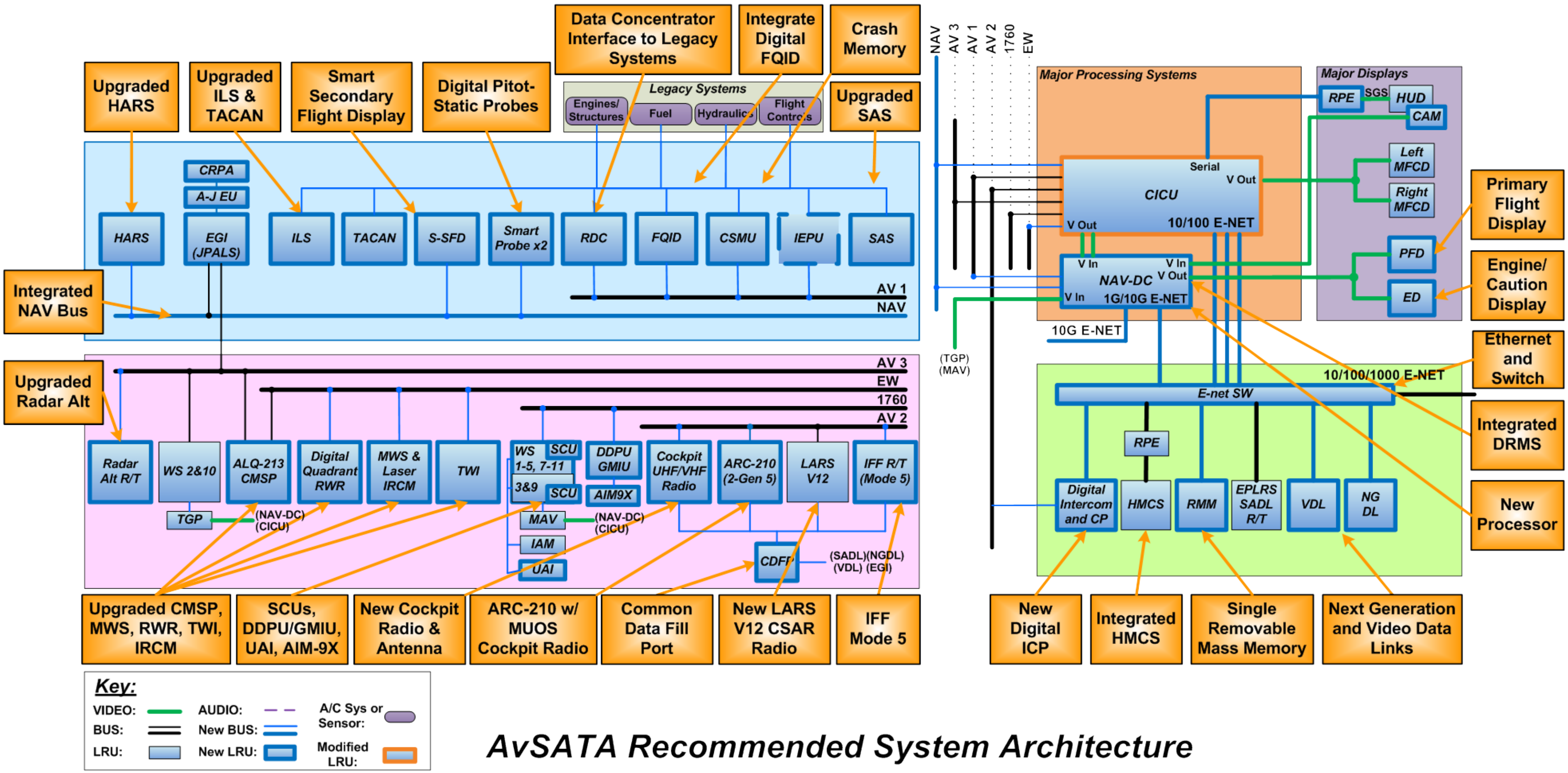


AvSATA Recommended System Architecture

Biographies

Richard L. Sorensen is a Staff Systems Engineer at KIHOMAC Inc. He has over twenty eight years experience in systems engineering and systems architecture in both military and civil applications.

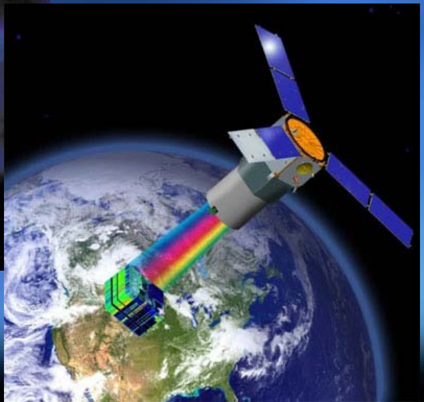
Adam Grimm is Director for Strategic Programs at KIHOMAC Inc. He has over eight years working logistics, engineering and requirements for U.S. Air Force aircraft and net-centric and command and control systems.

Jerry L. Coates, M. E. E. E., is the A-10 OSS&E Integrator for the A-10 System Program Office (OO-ALC/ 538th ACSG/EN). He has 21 years of experience with the USAF at OO-ALC including 2 years as an AF Exchange Engineer in Manching, Germany at the German Airworthiness Certification Airbase WTD 61, and 11 years of experience in industry (Boeing, SSAI, Robert Bosch and as an independent consultant)

SmallSat Conceptual Design Trade and Cost Modeling Tool

Dr. Deganit Armon

Advatech Pacific, Inc.



NDIA 12th Annual Systems Engineering Conference

Systems Engineering Development Environment

October 29, 2009

Team

- Advatech Pacific, Inc.
  - John Carsten
  - Deganit Armon
  - Dana Sherrell
  - Michael Paisner
  - Mark Sutton
  - Steve Mysko
  - Paul Dorman
  - David Cantwell
- MCR LLC
  - Roy Smoker
  - Daniel Feldman
- Air Force Research Laboratory, Space Vehicles Directorate
  - Brent Hamilton
  - Ross Wainwright
- Tecolote Research
  - Al Milton
  - John Trevillion
  - Darren Elliott
- Rocket Science Solutions, Inc.
  - Jerry Sellers

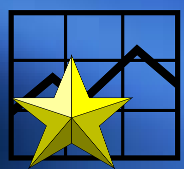
Advatech Company Overview

- Founded in 1995, Owned/Operated by Aerospace Engineers
- Locations in California, Arizona and Virginia
- R&D and Engineering Services
  - Integrated tool development and analysis
    - Space vehicle modeling
    - Launch vehicle design and cost
    - Hypersonic vehicles
    - Trajectory analysis
    - Range safety (Responsive Range Safety)
  - Software design and development
  - Engineering design and analysis
    - Structural
    - Thermal
    - Composites
    - Advanced space propulsion (electric / nuclear)
    - Tactical communications

Traditional Design Approach

Early Design Challenges of High-Performance Complex Systems

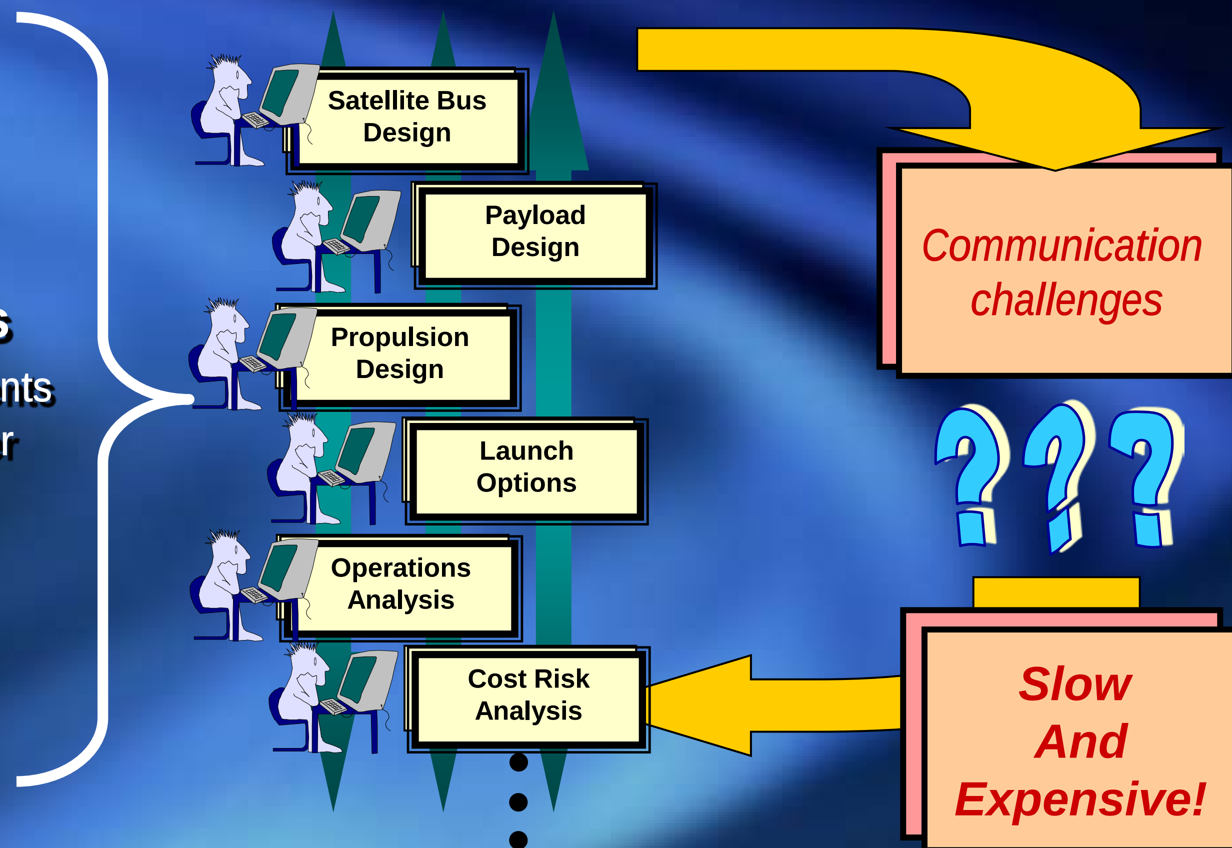
What is the current design process?



System Requirements

- Mission requirements
- Size, weight, power
- New technology insertion
- Performance
- Schedule

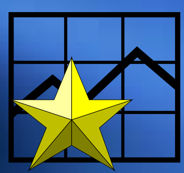
•
•
•



Integrated Design Approach

Solution to Early Design Challenges of High-Performance Complex Systems

Integrated optimizing tools provide:

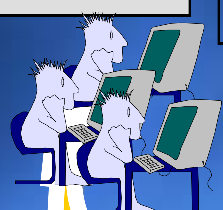


System Requirements

- Mission requirements
- Size, weight, power
- New technology insertion
- Performance
- Schedule
- •
- •
- •

Integration Core Module

User Interface Module



Bus Module

Payload Module

Propulsion Module

Launch Module

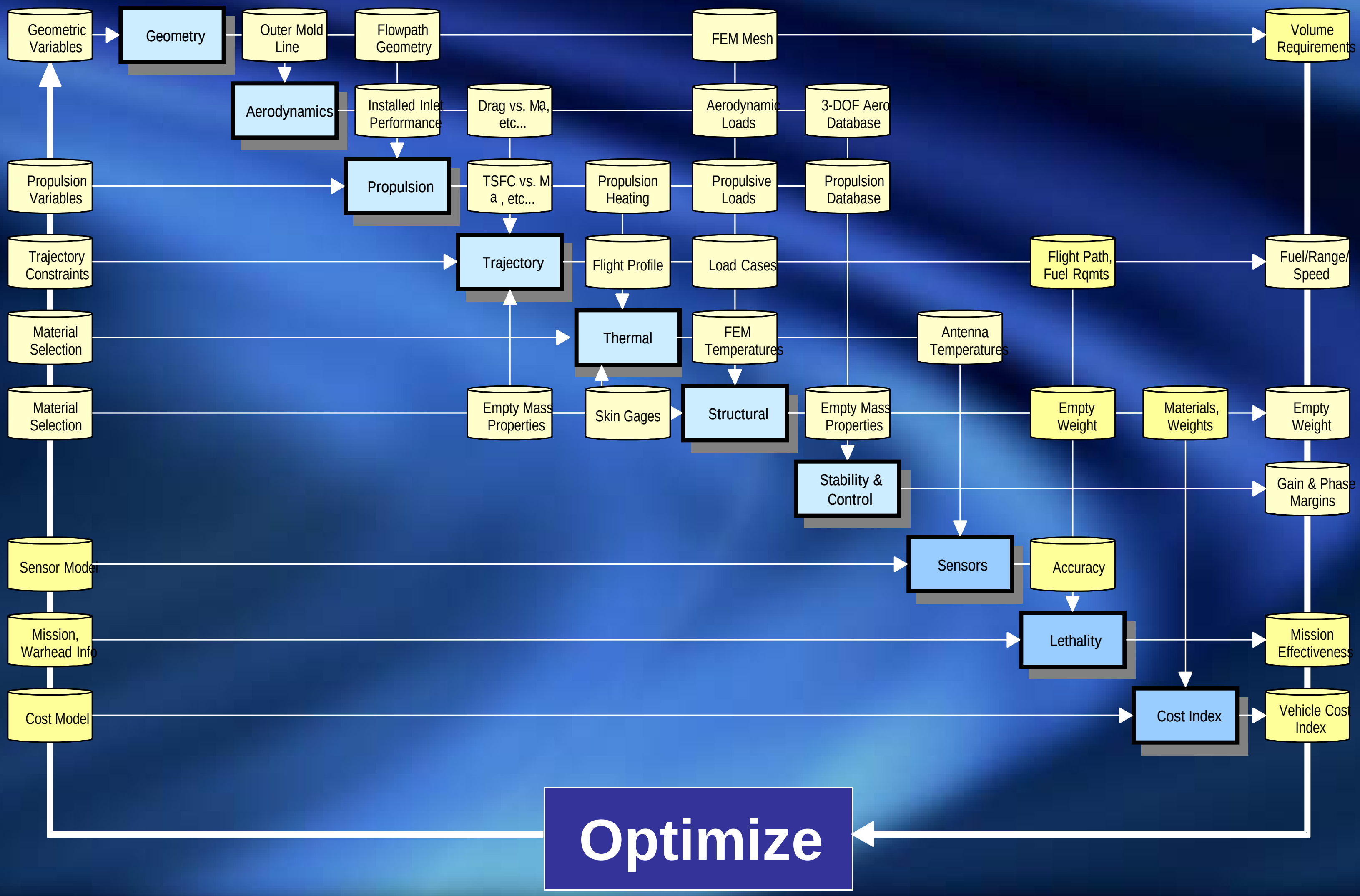
Operations Module

Cost/Risk Module

•
•
•

In Days Not Weeks!

Integrated Tool Suite Process Flow



Integrated Tool Suite Benefits

- Continuous trade study capability throughout the acquisition life cycle
- Iteratively model key parameters in the pre-system acquisition phase
  - ConOps
  - Performance
  - Cost
  - Schedule
  - Technology risk
- Responsive turnaround – days, not weeks!
- System and subsystem trade analysis
- Continuous knowledge capture and update

Fundamental enabler for building the best performing system within the cost, schedule and technology constraints

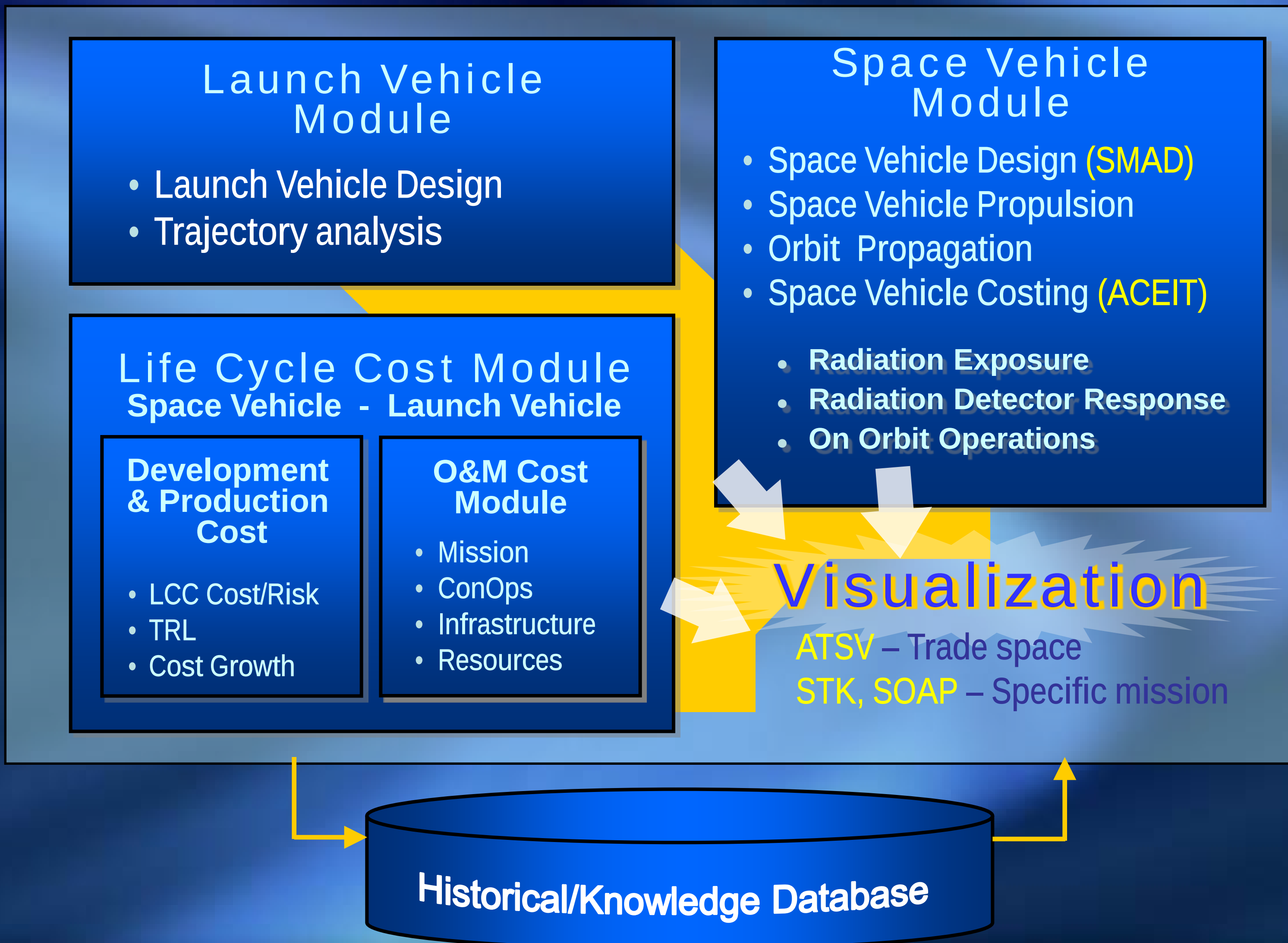
Advatech Integrated Projects

- Space vehicle design and cost (ACES-ISET)
- Advanced Cost Model (ACM)
- Launch vehicle design, operations and cost (IPAT)
- Hypersonic aeromechanics tool (IHAT, FPAT)
- Integrated Physics Based Cost / Risk Analysis Tool (ICAT)
- Composite Rotor Blade and Wing Structural Design Tool
- Component Integrated Modeling Simulation and Test Analysis Environment (CIMSTA)
- Naval Engineering Analysis Tool (NEAT)
- Virtual Satellite Integration Effort (VSIE)
- Small Satellite Launch Vehicle (SPRITE)
- Analytical Methods for Sandwich Core Termination
- Integrated High Payoff Rocket Propulsion Technology (IHPRPT)
- Aircraft Vulnerability Model (AVM)
- Combined Hall Effect Thruster Code (CHETC)
- Field Reverse Configuration (FRC) Thruster Model – Orbit Transfer Vehicle System Model
- Highly Mobile Tactical Communications (HMTC)
- Integrated Solid Motor Analysis Tool (ISMAT)

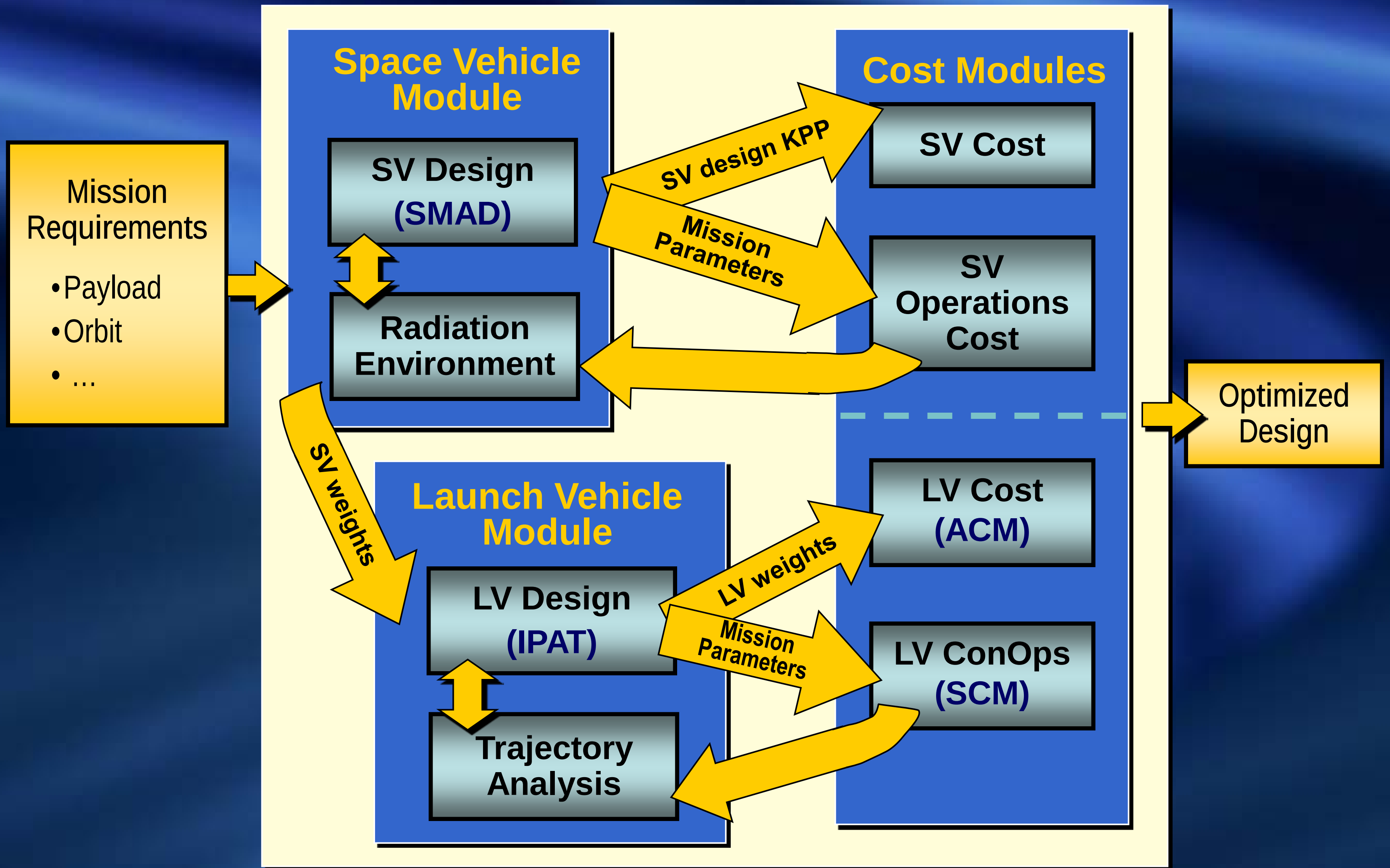
SmallSat Conceptual Design Tool

- Advanced Computational Engineering Simulator – Integrated Space Analysis Tool (ACES-ISET)
- Customer: Air Force Research Laboratory, Space Vehicles Directorate, Kirtland AFB, NM
- Partners: Tecolote Research, MCR LLC, RSSI
- An integrated, multi-disciplinary engineering tool suite
  - Optimizes the design and cost of space vehicles
  - Models the space environment
  - Selection of launch vehicles and modeling launch operations
  - Perform mission planning trade studies
  - Visualization of results

Integrated System and Cost Model (ISCM) - Tool Suite



ACES Conceptual Design



Cost Estimating

- Cost modules fully integrated with design tools
- Cost estimating relationships based on
  - historical data
  - sub-system weights
  - materials
- Historical data used to identify cost growth rates related to Technical Readiness Levels (TRL)
- Cost and schedule are related to TRL and system engineering milestones
- Built in risk estimating capabilities

Cost Risk Estimates

Cost growth incurred as technology matures

PDR → CDR → FCA → IOC

TRL 4-5 | TRL 5-6 | TRL 6-7 | TRL 7-8

Risk

Triangular bounds (L,M,H) on weights drive S-Curves

Determined using FRISK, a deterministic risk analysis tool

S-Curves shift to the right with cost growth

Applications

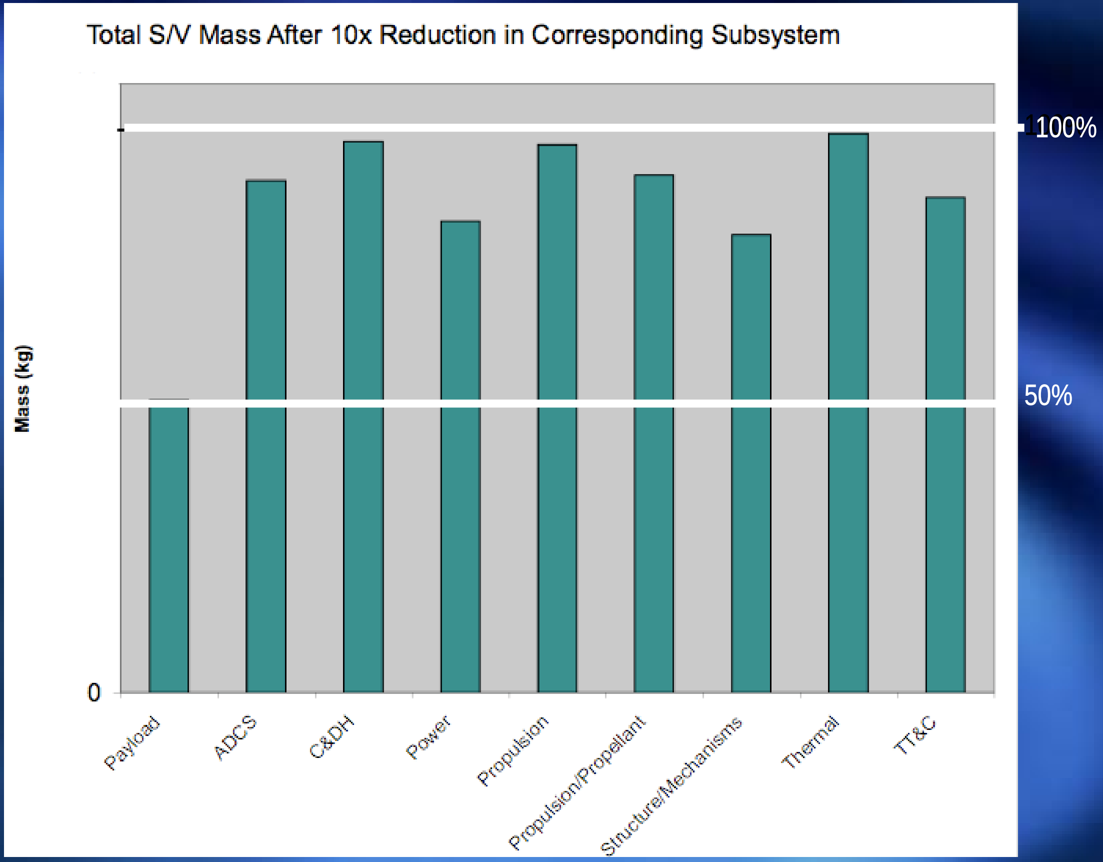
- **Examples of Trade Studies**
  - Effect of subsystem reduction on total vehicle design
  - Concept evaluations of proposed TacSat-5 concepts
  - Cost impact of alternative TacSat-3 designs
  - Launch vehicle selection and cost for satellite constellation
  - Trajectory analysis for DSX alternative orbits
  - Concept modeling for ORS modular satellite architectures

Sensitivity Study

- Study highlights
  - Quantitative and qualitative data on the impact of decreasing Size, Weight and Power (SWAP) of individual subsystems on the overall space vehicle SWAP
  - Insight on space vehicle subsystems & components interaction
  - Determined feasibility of reducing Space Vehicle mass by factor of 4
    - **Only through cross-subsystem functionality**
  - Identified two major areas for future focused research
    - **energy conversion**
    - **structural materials**
  - Presented at the 6th Responsive Space Conference 2008

> Expectations for return on research investments can be bound by quantifying system-level effects of a single breakthrough

Sensitivity Study – Sample Results



Effect of subsystem 10x mass reduction on total space vehicle mass
Each bar represents the effect of a single subsystem mass reduction

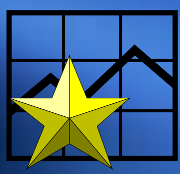
TacSat-5 Concept Evaluations

- Study highlights
  - Source solicitation evaluation
  - Tiger Team approach

Integrated Design Approach

Solution to Early Design Challenges of High-Performance Complex Systems

Integrated optimizing tools provide:



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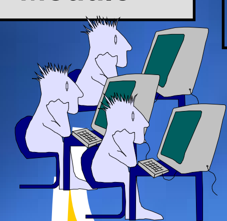
Integration Core Module

User Interface Module



- Bus Module
- Payload Module
- Propulsion Module
- Launch Module
- Operations Module
- Cost/Risk Module
- •
- •
- •

In Days Not Weeks!

TacSat-5 Concept Evaluations

- Study highlights
  - Source solicitation evaluation
  - Tiger Team approach
  - Thirteen concepts evaluated (classified and unclassified)
  - Identified and quantified issues with concept proposals:
    - Projected costs that exceed available budget
    - Costs that assume payload design heritages not supported in proposal
    - High risk payloads based on low TRLs, long development schedules or payloads exceeding mass budget limits
  - Identified and quantified issues with transitioning to operational version
  - Demonstrated that some proposals/CONOPS
    - Contained inconsistent assumptions
    - Contained questionable assumptions that needed further investigation

Knowledge gained during conceptual design phase enabled decisions about designs and mission capabilities before a large investment was committed

Alternative TacSat-3 Designs

- Study highlights
  - Ongoing study
  - Determine subsystem design changes needed to create an "operationalized" version of TacSat-3.
  - Model and evaluate design modifications
    - Baseline design
    - Payload reductions
    - Increased mission length
    - Subsystem redesign with newer technologies
  - Determine cost of design modifications
  - Select and determine procurement costs of launch vehicles needed to launch a satellite constellation

Cost estimates for design modifications are affected by subsystem heritage and technology maturity.

Lessons Learned

- Selecting integration environment
  - License cost
  - Performance (speed)
  - Portability (platforms)
  - Flexibility and ease of development
  - Scalability
  - Automated parameter management (facilitates trade studies)
  - User interface
- Selecting M&S tools to be integrated
  - Existing customer tools
  - Validation level (industry accepted)
  - OTS versus development
- Data availability and reliability
  - Proprietary data
  - Validation level
- Export control and use restrictions
- Managing customer expectations

Conclusions

- Integrated tools suites
  - provide substantiated, traceable and reproducible results
  - reveal interdependencies of cost, risk, schedule, and performance
  - provide higher confidence in cost and schedule estimates
  - enable better management of technology investment by decision makers

Concepts and processes are applicable to design domains beyond space

An Integrated RAM Approach to System Design and Support

Bob Finlayson
The Johns Hopkins University
Whiting School of Engineering

Challenge

"The operations and support phase of the system life cycle is the time during which the products of the system development and production phases perform the operational functions for which they were designed. In theory, the tasks of systems engineering have been completed. In practice, however, the operation of modern complex systems is never without incident."

Kossiakoff, A., Sweet, W., *Systems Engineering Principles and Practice*

Reliability, Availability, Maintainability

- The most important aspect of O&S design
- Directly influences:
  - Operational effectiveness
  - Safety
  - Supply support
  - Maintenance planning
  - Manpower and personnel
  - Cost
- Indirectly influences:
  - Management of the Supply Chain
  - Technical Data
  - Facilities
  - Support Equipment

JOHNS HOPKINS UNIVERSITY

Failure Due to a Bad Design

Tacoma Narrows Bridge
07 November 1940

Tacoma Narrows Bridge
2006

JOHNS HOPKINS UNIVERSITY

Failure Due to Multiple Factors

<u>Interstate 35 Bridge, Minneapolis, MN, 01 August 2007</u>

-Excessive loads – using the bridge in an unintended environment

-Undersized gusset plates – poor design

-Corrosion – improper maintenance

-Design – geometric failure (bowing of the U10 joint)

JOHNS HOPKINS UNIVERSITY

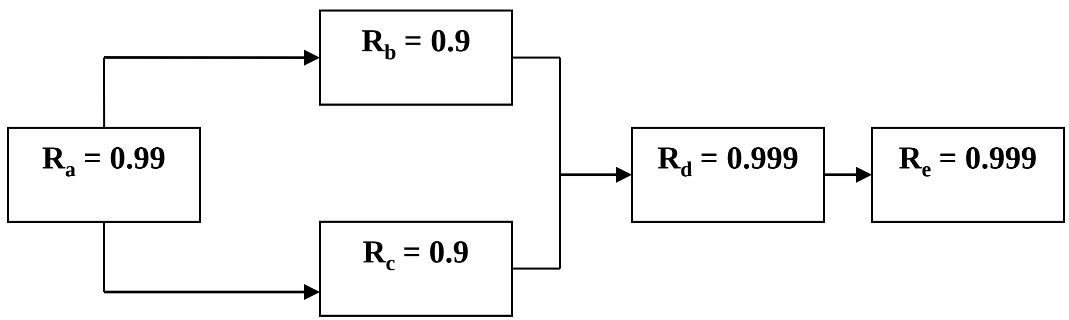
Program Failure Waiting to Happen

- “The reliability for the ABC system shall be 0.97 and it is listed in the Capabilities Development Document as a Key Performance Parameter.”
- “How did you arrive at 0.97? Was it derived mathematical based on similar systems, what current technology can allow, or on requirements for mission success?”
- “None of the above - 0.97 is what the user thinks he can live with.”

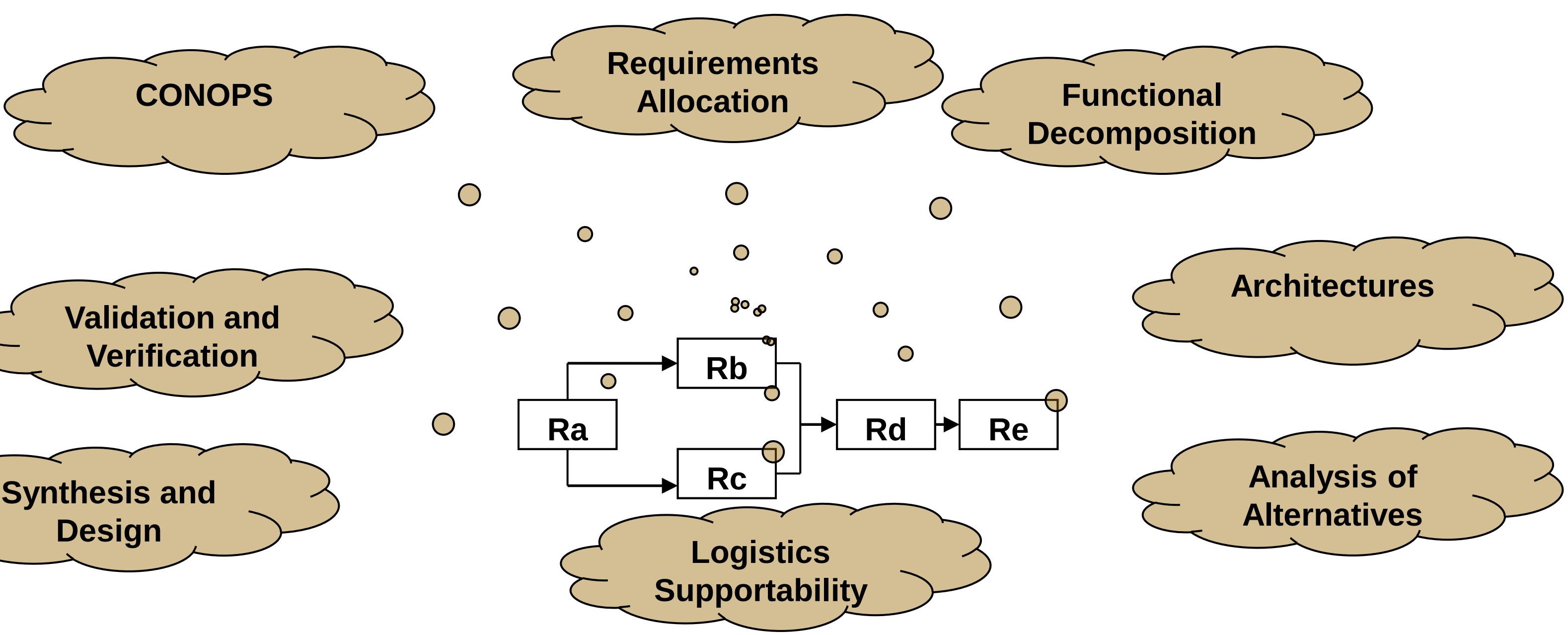
Calculating Reliability

System Schematic

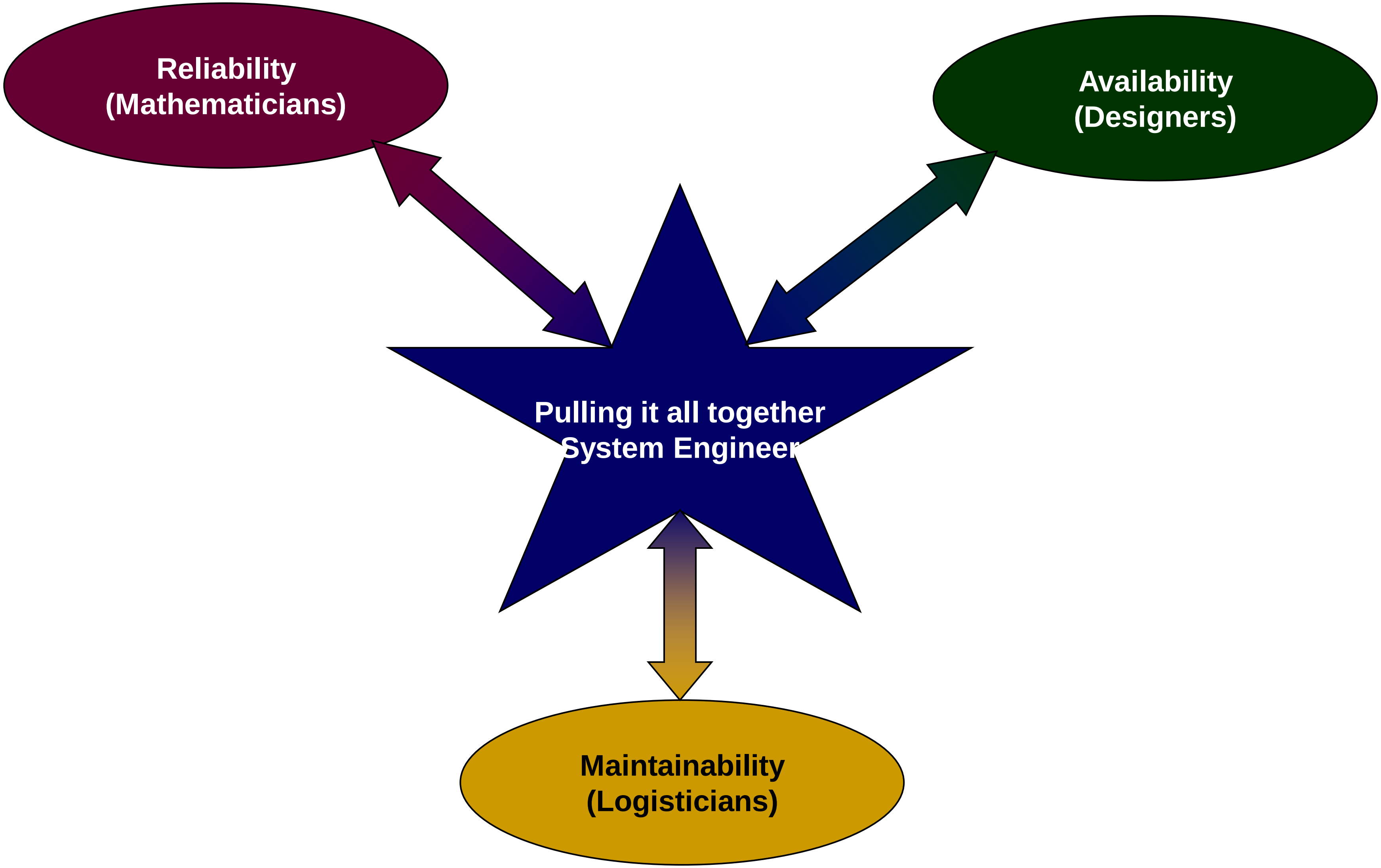
Easy



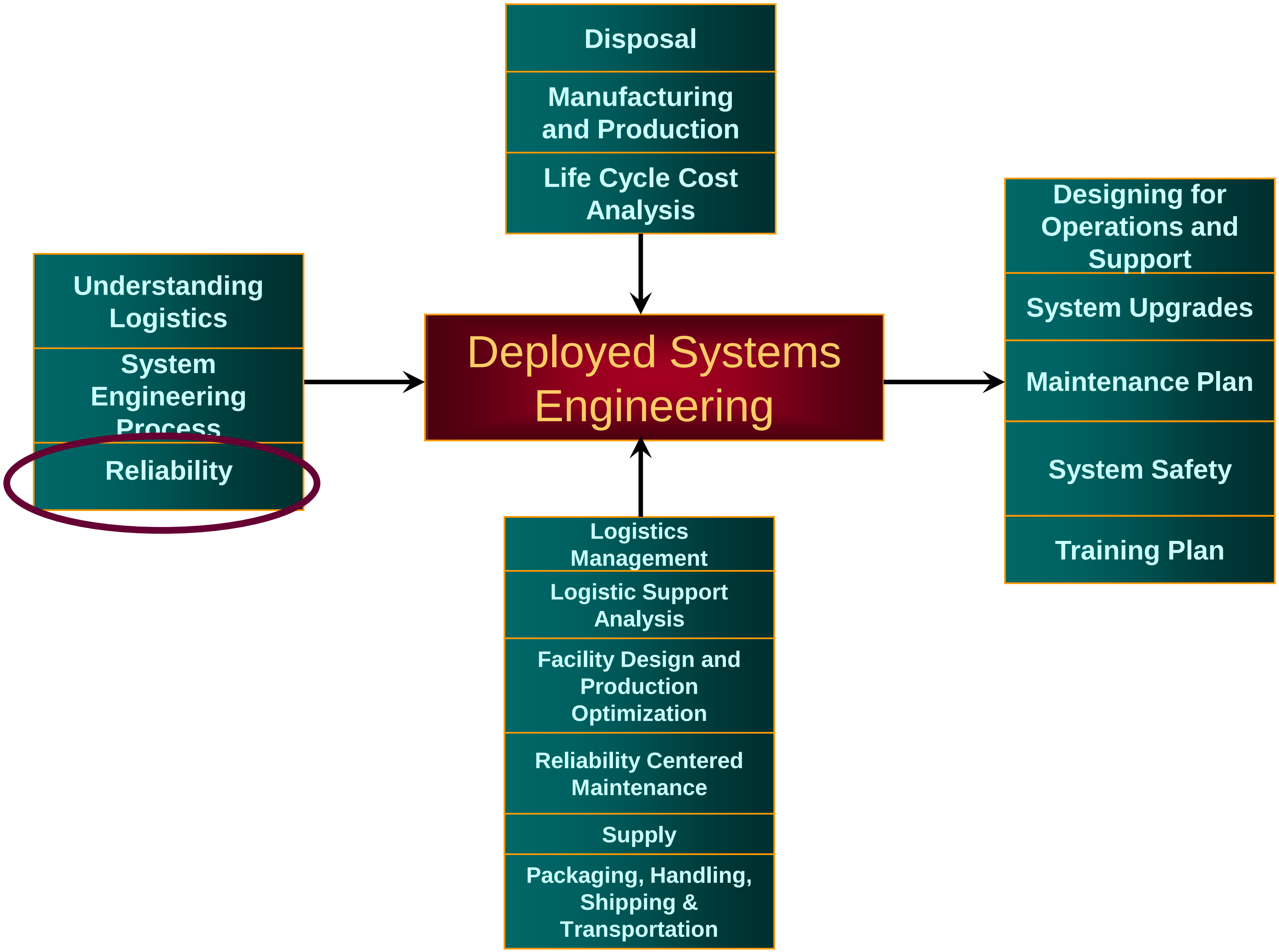
Hard



What's Behind the RAM?



Structured Analysis for Deployed Systems Engineering



Limitations/Constraints

- Availability of data
  - Historical, analogy, parametric analysis
- Use of the correct reliability prediction model
  - Do you have a clear understanding of system?
- Understanding/modeling of operational environment
  - Will not account for all of the factors that affect system reliability
- Accounting for operation of the system itself
  - User may not employ the system as designed

100% reliability does not exist because of cost, acceptability of failure, and in truth…it is impossible to obtain

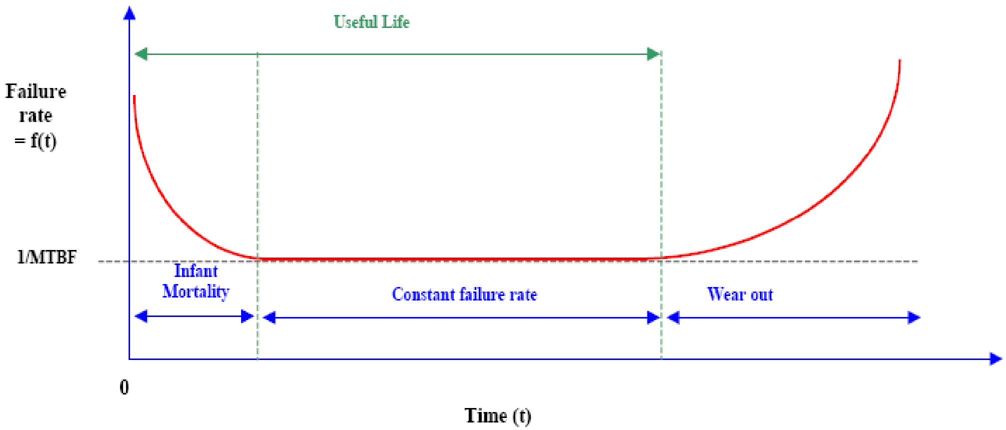
Stakeholders/Contributors

- Similar systems in a similar environment
  - Data can help determine the reliability of the new system
- System designers
  - Account for reliability throughout the design
- Evaluators
  - Assess if the system meets reliability requirements
- Manufacturers
  - Affects system assembly <u>and</u> quality control
- Product introduction team
  - Early barometer of system’s reliability
- Product support team
  - Best assessment of reliability in system design
- Users and maintainers
  - Ultimately affects system performance; perhaps more than any other measure

Do’s and Don’ts in Reliability Applications and Analysis

Addressing Reliability

- Do you truly understand the problem at hand?
  - Environment, requirements, CONOPS
- Have you set the boundary conditions?
  - Assumptions, limitations
- Have you correctly assumed equilibrium?
  - Modeling
- Can you solve for the unknowns?
  - Design and verification



- This can be a typical behavioral model for an organic and inorganic system – looks fairly benign
- In reality, randomness, environmental effects, catastrophic events, etc., will skew the outcome

Failure Due to a Bad Design

Tacoma Narrows Bridge
07 November 1940

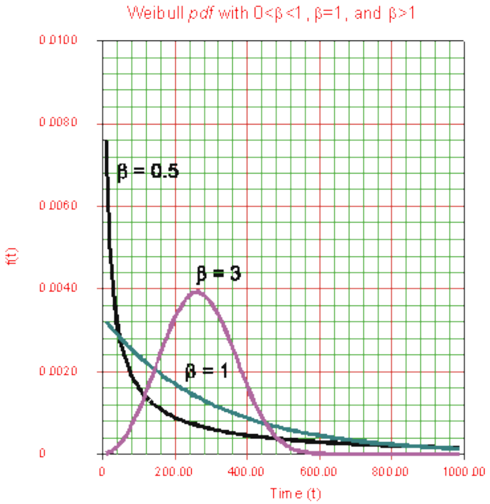
Tacoma Narrows Bridge
2006

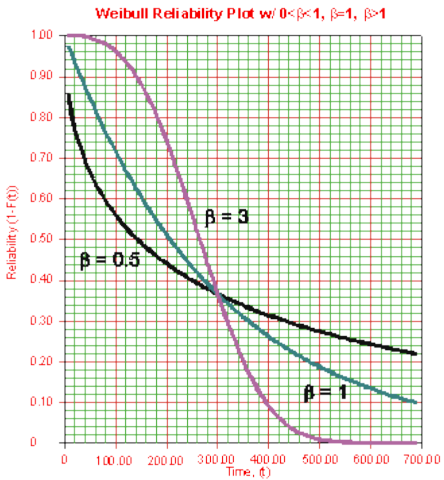
Some Basics

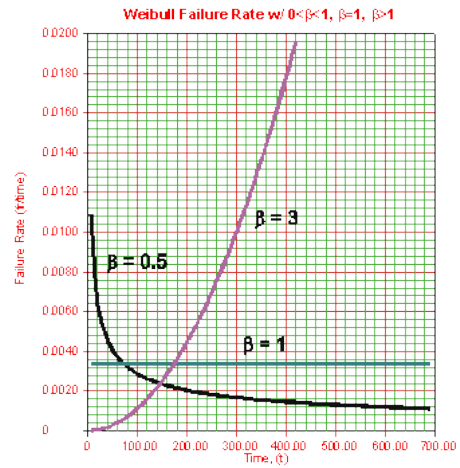
- Select the correct probability distribution function
  - Exponential
    - Constant failure rate model for continuously operating systems
    - Probability of failure for some time period in the future is independent of age (i.e., “memorylessness”)
  - Normal
    - Summing of random effects
    - Assumes independence between events
    - Events equally weighted (or no one which is dominant)
- Look at component interactions and interfaces
  - Conditional probability
- Consider redundancy in design
  - Be careful!
- Don’t be afraid of Weibull

Weibull Distribution

- Most widely used in reliability calculations
  - Appropriate use of parameters can model a variety of failure rate behaviors (2 and 3 parameter distributions)
- Used to calculate wear in and wear out phenomena as well as constant failure rates
  - Take on shape of other distribution functions by varying its shape parameter







Why Weibull?

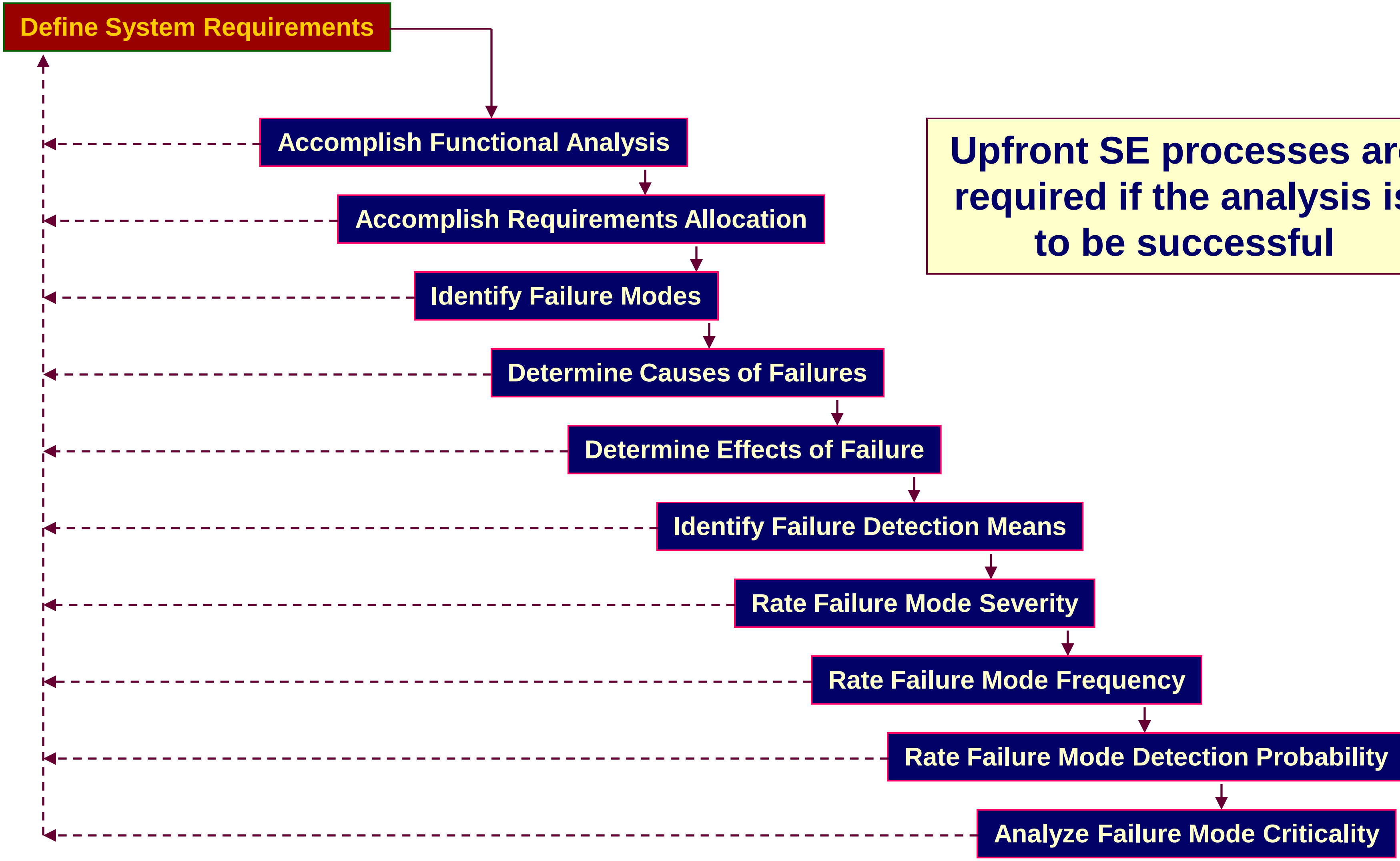
- Exponential assumes all units are being utilized in exactly the same manner and are exposed to the same stresses

- However…
  - Failure characteristics vary depending on their usage
  - Failure distributions are different for different types of systems (e.g., mechanical versus electronic)

- Normal, Lognormal and Weibull distributions are time dependent
  - That is, reliability of a device is a strong function of its age
  - Require at least two parameters

- Weibull looks at historical data or data from a similar system being used in a similar manner to make predictions on behavior and failures

Applying FMECA



Upfront SE processes are required if the analysis is to be successful

Blanchard, Benjamin S., "Logistics Engineering and Management (Sixth Edition)"

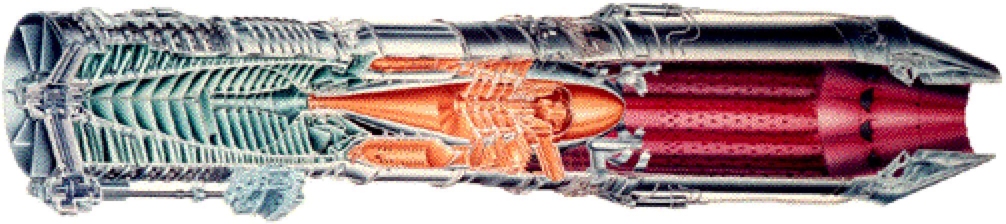
Failure Interactions

- Best analyzed through Markov Analysis and state diagrams
- Calculates reliability for the following scenarios
  - Independent components
  - Load-Sharing systems
  - Standby systems
    - Idealized system
    - Failures in standby state
    - Switching failures
    - Primary system repair
  - Multi-component systems
  - Combination of systems
- Availability
  - Standby redundancy
  - Shared repair crews

Example

Systems Approach to Reliability

- Reliability can only be increased if:
  - Component reliability is increased through design optimization
  - Component redundancy is built into the system
  - Interactions between the components are understood to a very high degree



Is a single engine failure an independent event?
If not, do you understand the collateral effects?
How do you model them to predict single engine failure?

Summary

- Requirements
  - Understand early in system development the reliability expectations
  - Determine if they are achievable
- Functional analysis and allocation and its effects on reliability
  - Best accomplished through a FMECA
- Synthesis
  - Build reliability into the design via component/subcomponent design, minimization of component interactions and redundancy
- Feedback
  - Predict component and system behavior via probability analyses (e.g., Weibull distribution function, M&S, etc.)
  - Determine if the initial design will meet performance and cost constraints; iterate and refine as required
- Verification
  - Ensure the test and evaluation activities address those areas that will provide the greatest visibility into system reliability; this is often overlooked
- Specification
  - Hold the manufacturer accountable for all aspects of reliability in the design

Economics of Human Systems Integration:

Early Life Cycle Cost Estimation Using HSI Requirements

2nd Lt Kevin Liu, USMC

MIT Graduate Research Assistant

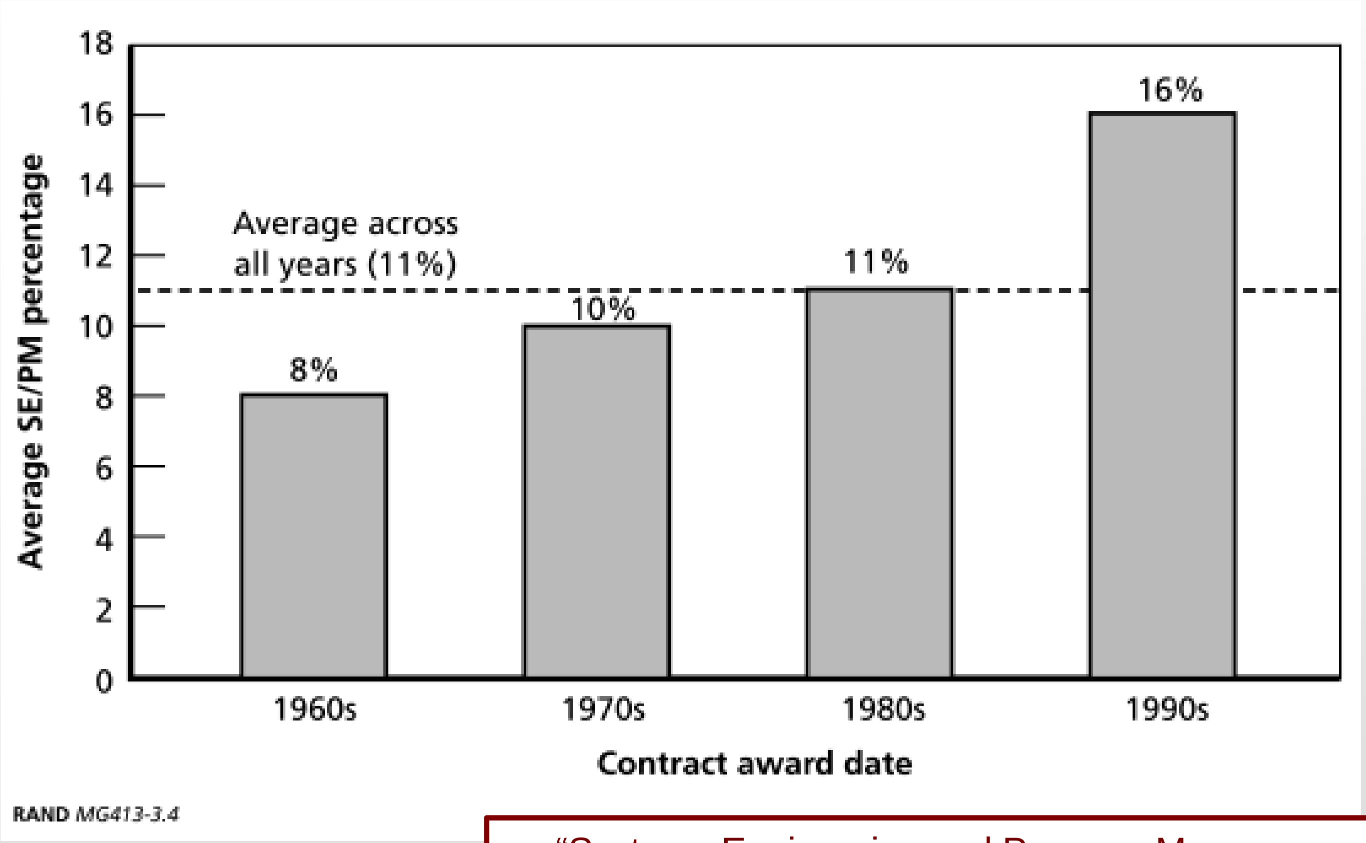
Research Advisors: **R. Valerdi and D. H. Rhodes**

12th Annual NDIA Systems Engineering Conference

October 29th, 2009 | San Diego, CA

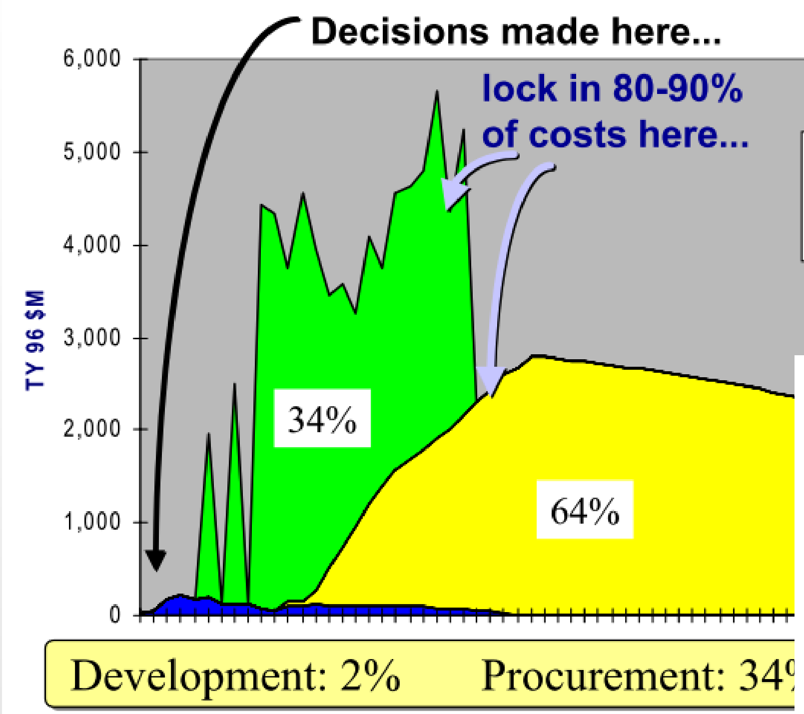
Why Measure HSI Cost?

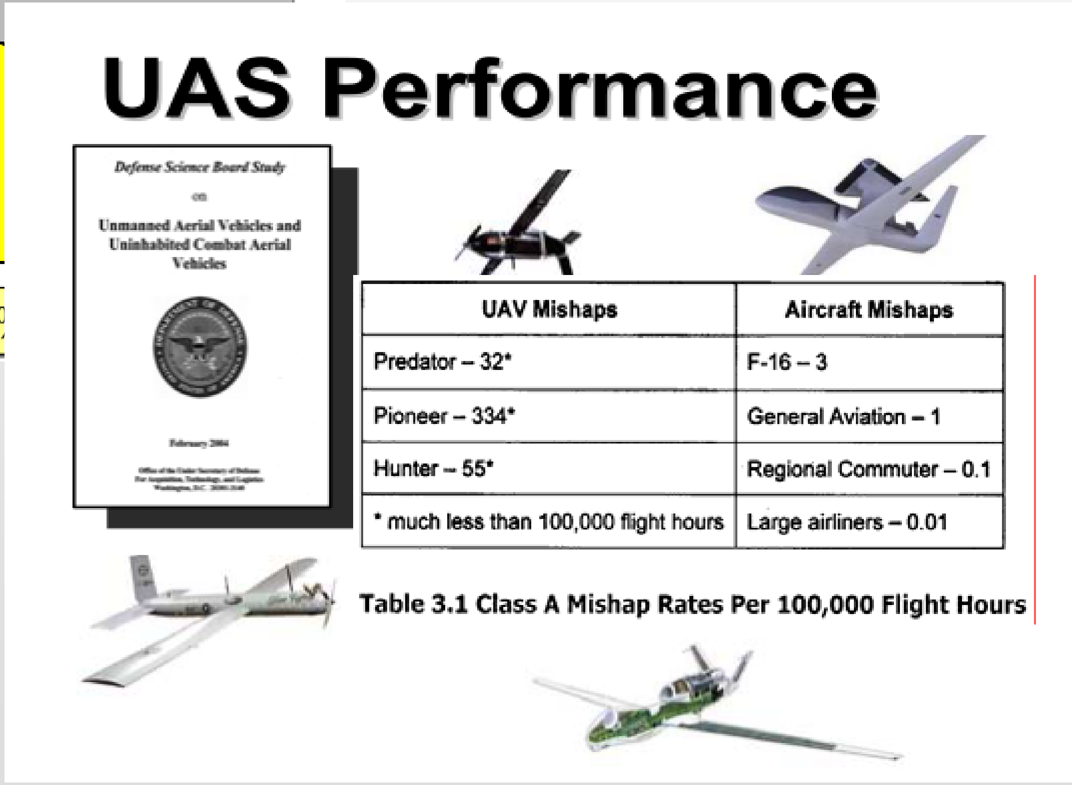
Aircraft SE/PM as a Percentage of Total Aircraft Development Cost Minus Outlier Development Programs, 1960s–1990s



"Systems Engineering and Program Management Trends and Costs for Aircraft and Guided Weapons Programs" – RAND Corp.

HSI for Reduction of Total Ownership Cost





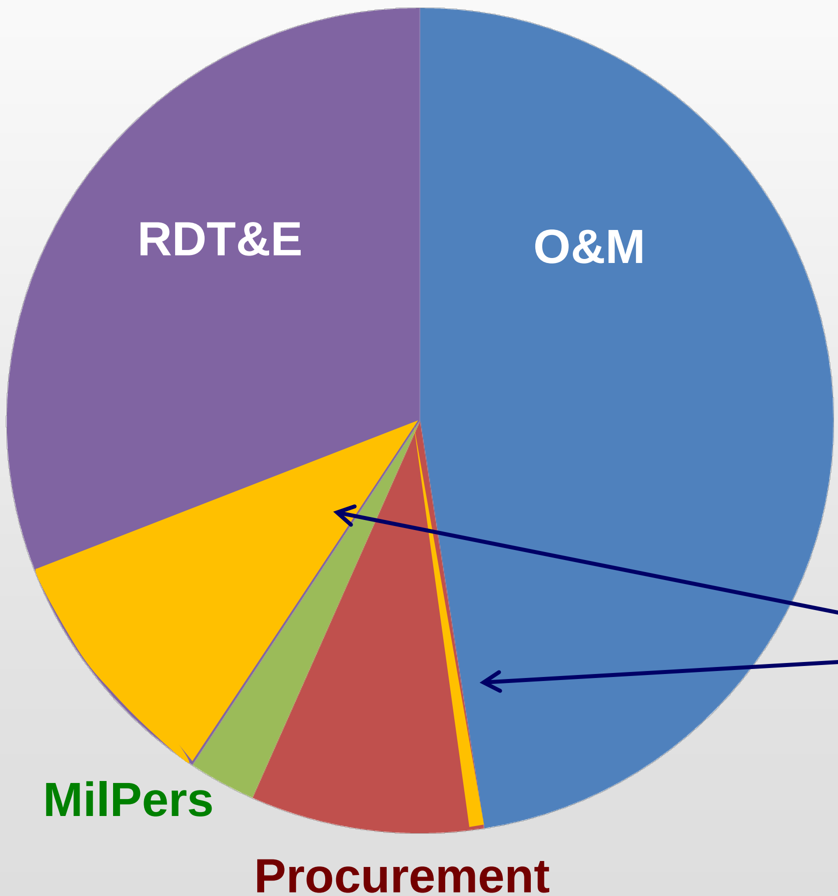
UAV Mishaps	Aircraft Mishaps
Predator – 32*	F-16 – 3
Pioneer – 334*	General Aviation – 1
Hunter – 55*	Regional Commuter – 0.1
* much less than 100,000 flight hours	Large airliners – 0.01

Table 3.1 Class A Mishap Rates Per 100,000 Flight Hours

SEARI Systems Engineering Advancement Research Initiative

PM Concerns about HSI Cost

Major Recent UAS



Averaged over 3 years

Total Budget >$1B, <$5B

= SE/PM Costs

Current Estimation Methods

Data from Historical Systems

!
"Rule of Thumb"

Estimate of SE/PM as Ratio of Total

Hours, total engineering development

Current Estimation Methods

15% SE

25% SE

8% SE

Data from Historical Systems

Factors influencing Estimate

Expert opinion
Technology Changes
Aircraft Weight
Units

New Program

Estimated 12% SE

Parametric Estimation of SE: COSYSMO

CO SYS MO

CONSTRUCTIVE SYSTEMS ENGINEERING COST MODEL

Parametric Estimation of SE: COSYSMO

CO SYS MO

CONSTRUCTIVE SYSTEMS ENGINEERING COST MODEL

Size Drivers

- # Requirements
- # Interfaces
- # Scenarios
- # Algorithms

+

3 Volatility Factors

Effort Multipliers

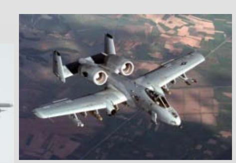
- Application factors
  - -8 factors
- Team factors
  - -6 factors
- Schedule driver

COSYSMO

SE Effort

Calibration





Inputs Needed to Implement COSYSMO

Requirements

- Counted from Requirements Documents (CDD, ORD)

- “shall” “will”, “must”

Requirements Decomposition

1. Determine system of interest
2. Can requirements be *test, verified,* or *designed?*
3. Sketch system of interest relationship to rest of system
4. Count only requirements at the level of the system of interest
5. Assess complexity of requirements

Inputs Needed to Implement COSYSMO

Effort Multipliers

Requirements understanding
Architecture understanding
Level of service requirements
Migration complexity
Technology risk
Documentation to match life cycle
Tool support

and Diversity of installations/platforms
of Recursive levels in the design
Stakeholder team cohesion
Personnel/team capability
Personnel experience/continuity
Process capability
Multisite coordination needs

Data source: input from high-level IPT.

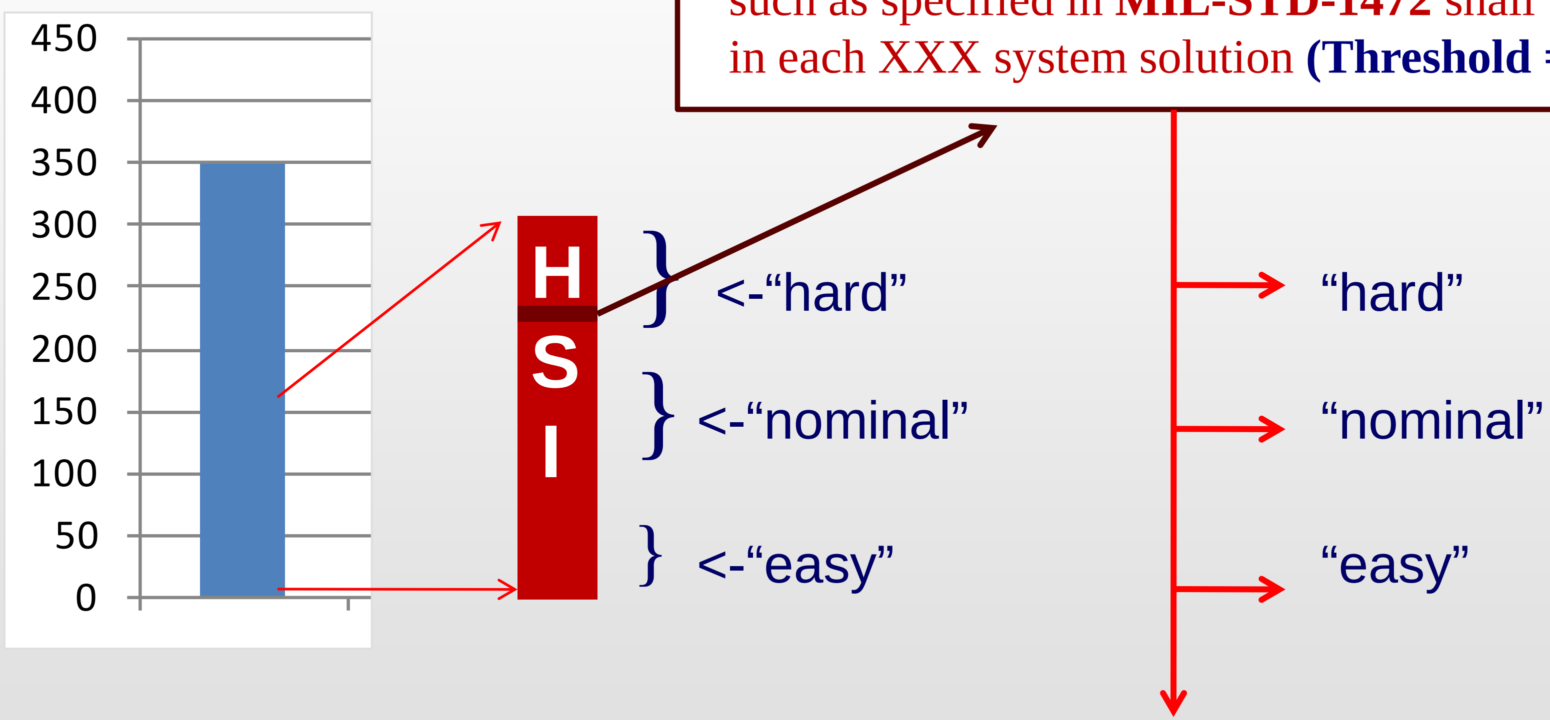
Application of COSYSMO to HSI

HSI requirements include, but are not limited to, any requirement pertaining to one or more domains of HSI, or the integration of those domains. Broadly, the term encompasses any requirement that contributes to the integration of human considerations into the system being developed.

Application of COSYSMO to HSI Notional Example

Human factors. Human factors engineering principles such as specified in **MIL-STD-1472** shall be employed in each XXX system solution **(Threshold = Objective).**

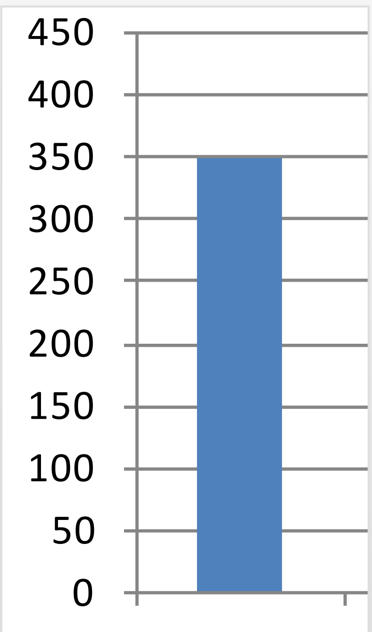
Shall's + Will's + Must's



Human Interfaces

Application of COSYSMO to HSI Notional Example

Shall's + Will's + Must's



CO SYS MO 1.1 — CONSTRUCTIVE SYSTEMS ENGINEERING COST MODEL — © 2007 Ricardo Valerdi — 5-Mar-07

ENTER SIZE PARAMETERS FOR SYSTEM OF INTEREST

	Easy	Nominal	Difficult	
# of System Requirements	100	200	50	500
# of System Interfaces				0
# of Algorithms				0
# of Operational Scenarios				0
				500

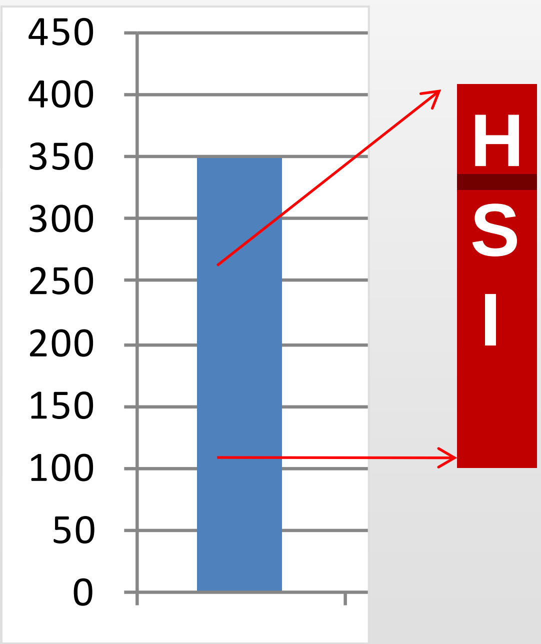
equivalent size

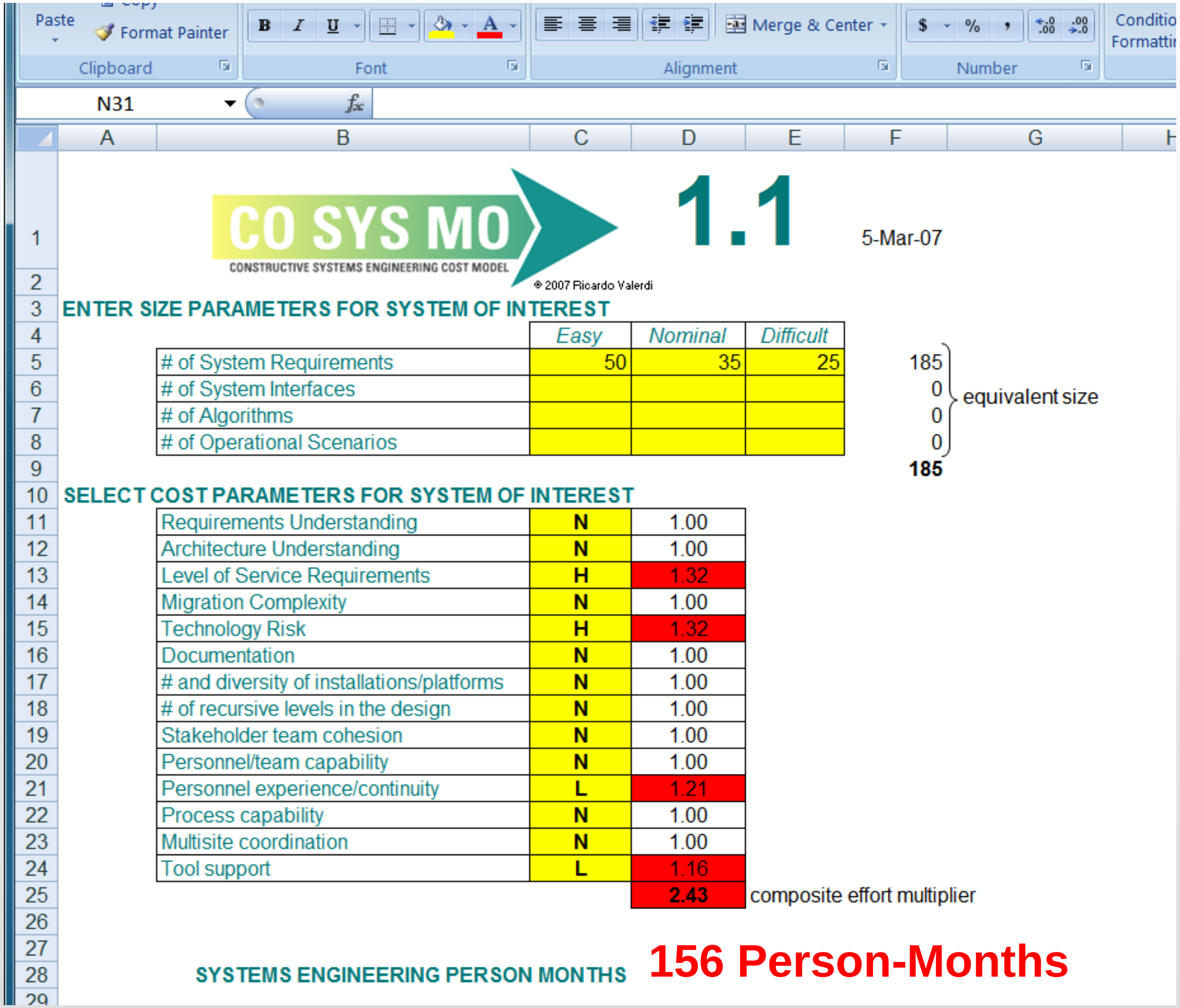
SELECT COST PARAMETERS FOR SYSTEM OF INTEREST

Requirements Understanding	N	1.00
Architecture Understanding	N	1.00
Level of Service Requirements	H	1.32
Migration Complexity	N	1.00
Technology Risk	N	1.00
Documentation	N	1.00
# and diversity of installations/platforms	N	1.00
# of recursive levels in the design	N	1.00
Stakeholder team cohesion	N	1.00
Personnel/team capability	H	0.81
Personnel experience/continuity	L	1.21
Process capability	N	1.00
Multisite coordination	N	1.00
Tool support	N	1.00
		1.29 composite effort multiplier

SYSTEMS ENGINEERING PERSON MONTHS **238 Person-Months**

Application of COSYSMO to HSI Notional Example





CO SYS MO — CONSTRUCTIVE SYSTEMS ENGINEERING COST MODEL	1.1			5-Mar-07
© 2007 Ricardo Valerdi				

ENTER SIZE PARAMETERS FOR SYSTEM OF INTEREST

	Easy	Nominal	Difficult	
# of System Requirements	50	35	25	185
# of System Interfaces				0
# of Algorithms				0
# of Operational Scenarios				0
				185

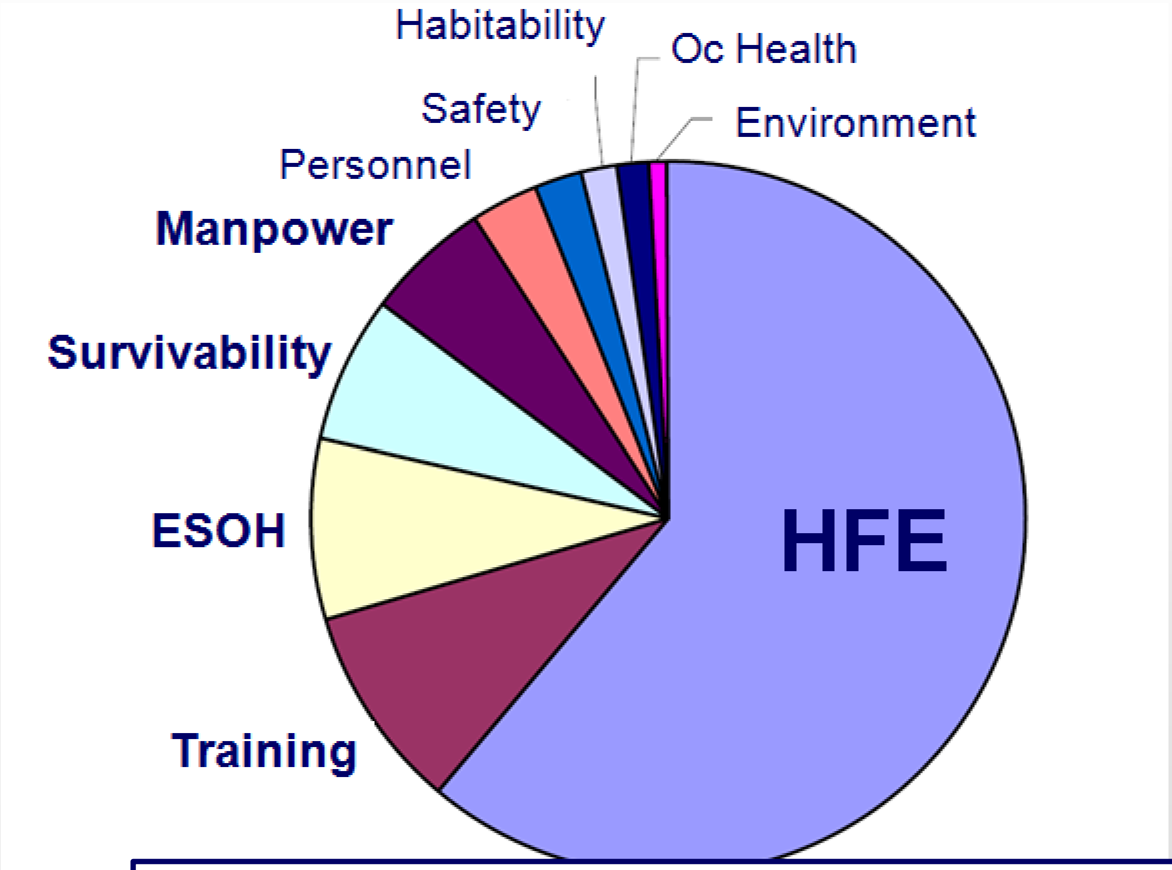
equivalent size

SELECT COST PARAMETERS FOR SYSTEM OF INTEREST

Requirements Understanding	N	1.00
Architecture Understanding	N	1.00
Level of Service Requirements	H	1.32
Migration Complexity	N	1.00
Technology Risk	H	1.32
Documentation	N	1.00
# and diversity of installations/platforms	N	1.00
# of recursive levels in the design	N	1.00
Stakeholder team cohesion	N	1.00
Personnel/team capability	N	1.00
Personnel experience/continuity	L	1.21
Process capability	N	1.00
Multisite coordination	N	1.00
Tool support	L	1.16
		2.43 composite effort multiplier

SYSTEMS ENGINEERING PERSON MONTHS **156 Person-Months**

Application of COSYSMO to HSI
Application to HSI Domains



HSI-related requirements found in Government-furnished requirements documents

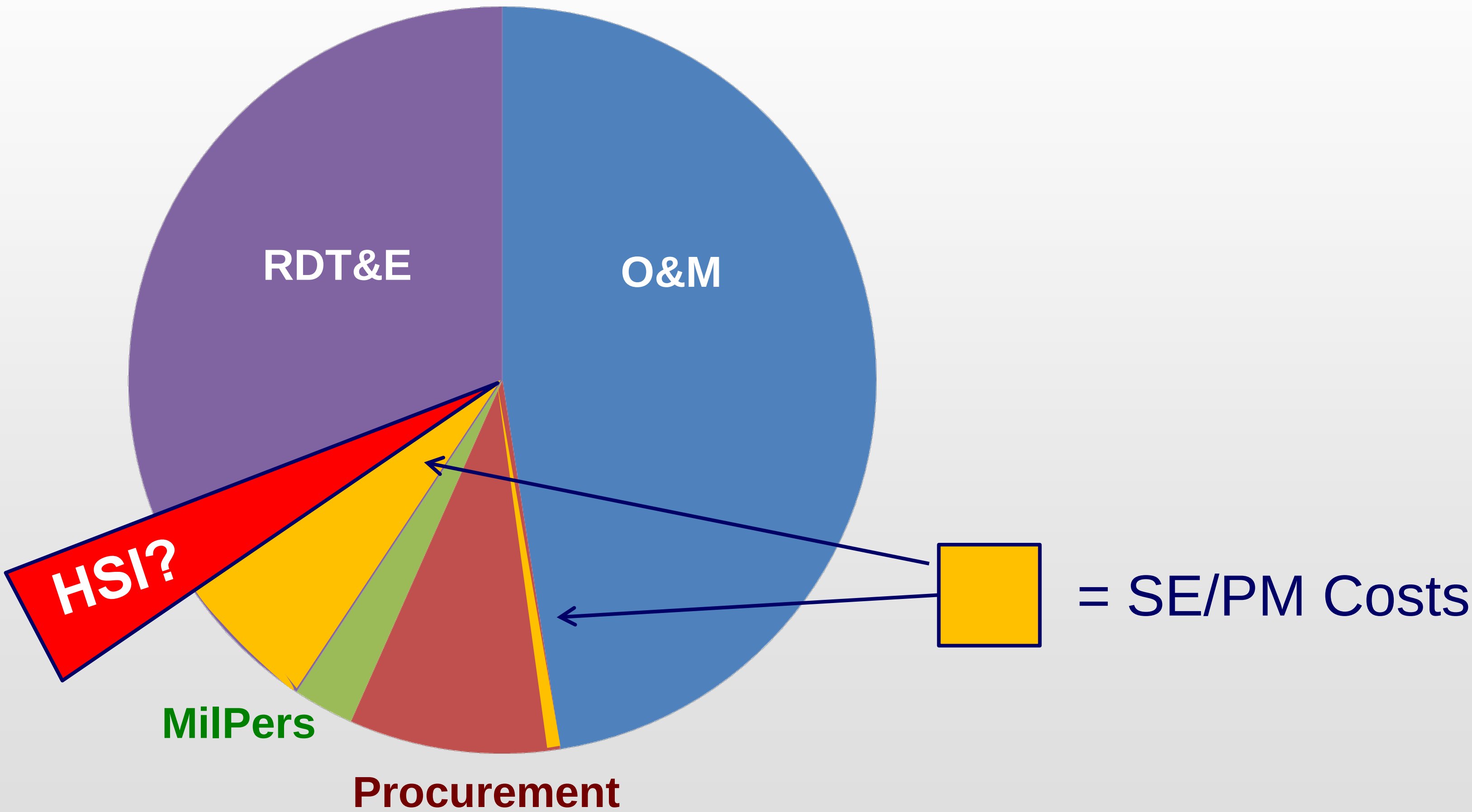
How complex are the safety requirements?

What tools are available for survivability analyses?

How verifiable are the environmental requirements?

How do these factors affect level of effort?

Application of COSYSMO to HSI Takeaways



HSI Already Integrated Into Systems Engineering

F119 Engine
On time
Within Cost
Superior Performance

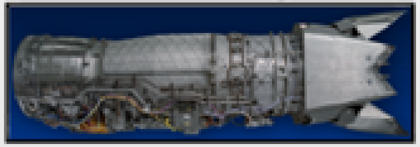
Types of studies
- Technology assessment
- Engine size and cycle
- Design life optimization
- Stage count, configuratio rotor speeds
- Evolution from demonstra to prototype

Tradeoff alternatives
Design and programmatic alternatives based on cost, schedule, and performance requirements

Evaluation criteria
- Safety
- Weapon system life cycle cost
- Supportability
- Reliability/maintainability
- Weight
- Operability/stability
- Manpower, personnel, and training

Planned trade studies
- Affordability
- Design refinement
- Pre-planned product improvement
- Materials and manufacturing technology

Balanced design



- Low-risk
- Affordable
- Achieves all ATF / NATF requirements

Yankel, J., & Deskin, W. (2002). "Development of the F-22 propulsion system."

“Essentially, all models are wrong, but some are useful”

George E. P. Box, statistician

How/When to Use COSYSMO for HSI

Use #1: “Are my ballpark estimates of SE/PM and HSI reasonable?”

Required Inputs:

- **<u>Existing</u> SE/PM Cost Estimate (rule-of-thumb, analogy, etc.)**
- **<u>Existing</u> draft requirements document**
- **IPT or expert analysis of requirements to identify HSI Requirements**
- **Optional: High-level DoDAF views for Operational Scenarios**

Useful Outputs:

- **Identification of SE/PM and HSI cost drivers**
- **Identification of major issues (risk, technology maturity, difficulty)**
- **Early warnings of large discrepancies**

Application:

- **Pre-Milestone A**
- **Can use any available information (DoDAF, Draft Requirements, etc.)**

How/When to Use COSYSMO for HSI

Use #2: "What is the *right* amount of SE/PM and HSI for my system?"

Required Inputs (in addition to Use #1):

- **Calibration using cost data from previous systems**
- **Decomposition of requirements into "sea-level" requirements or interfaces**

Useful Outputs (in addition to Use #1):

- **Better understanding of relative effort impact of each requirement**
- **Improved cost estimate compared to traditional methods**

Application:

- **Full System Life Cycle**
- **Can be constantly updated in response to new information or external pressures**

Future Work

Recently Developed Resources Useful for Implementation of COSYSMO for HSI

SEAri
Systems Engineering Advancement Research Initiative

Acknowledgments

SEAri
Systems Engineering Advancement Research Initiative

Pratt & Whitney
A United Technologies Company

The views expressed in this presentation are those of the authors and do not reflect the official policy or position of the United States Air Force, Marine Corps, Department of Defense, or the U.S. Government.

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An Evidence-Based Personnel Competency Assessment Framework for Major Defense Acquisition Programs (MDAPs)

Barry Boehm, Dan Ingold, Winsor Brown, USC
Paul Componation, UAH

NDIA Systems Engineering Conference
29 October 2009

Outline

- Competency Assessment Purposes and Models
  - SERC SE Effectiveness Measures Scope Decisions
- MDAP SE Competency Assessment Elements
  - Evidence-based SE reviews and tools
  - Early life cycle concepts of operation
  - SE Competency Assessment Framework
- Results of Pilot Evaluations
- Benefits of Usage
- Next Steps and Research Issues
- Conclusions

Competency Assessment Purposes and Models

- Personnel Certification Models
  - Assess degree of mastery of core SE knowledge, skills, abilities (KSAs)
  - Assessment via examination, resume, artifacts produced
- Enterprise KSA Inventory, Career Progression Models
  - Record degree of mastery of core and business-domain SE KSAs
  - Assessment via educational and project experience records
- Project SE Staffing Capability Models
  - Assess commitment to provide project-critical skills
    - Tailorable subset of core SE skills
    - Extendable for project-specific skills
  - Assessment via educational and project experience records, interviews

Types of Milestone Reviews

- Schedule-based reviews (contract-driven)
  - We'll hold the PDR on April 1 whether we have a design or not
  - High probability of proceeding into a Death March
- Event-based reviews (artifact-driven)
  - The design will be done by June 1, so we'll have the review then
  - Large "Death by PowerPoint and UML" event
    - Hard to avoid proceeding with many unresolved risks and interfaces
- Evidence-based commitment reviews (risk-driven)
  - Evidence provided in Feasibility Evidence Description (FED)
    - A first-class deliverable
    - Based on concurrently engineered ConOps, specs, and plans
  - Shortfalls in evidence are uncertainties and risks
  - Should be covered by risk mitigation plans
  - Stakeholders decide to commit based on risks of going forward

Content of Evidence-Based Reviews

- *Evidence* provided by developer and *validated by independent experts* that:

  If the system is built to the specified architecture, it will
  - Satisfy the specified operational concept and requirements
    - Capability, interfaces, level of service, and evolution
  - Be buildable within the budgets and schedules in the plan
  - Generate a viable return on investment
  - Generate satisfactory outcomes for all of the success-critical stakeholders
- Shortfalls in evidence are uncertainties and risks
  - Should be resolved or covered by risk management plans
- Assessed in increasing detail at major anchor point milestones
  - Serves as basis for stakeholders' commitment to proceed
  - Serves to synchronize and stabilize concurrently engineered elements

Can be used to strengthen current schedule- or event-based reviews

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SEPAT Seeks Performance Evidence

That can be independently validated

Exposure	Question #	Impact: Critical / 40-100%	Impact: Significant / 20-40%	Impact: Moderate / 2-20%	Impact: Little-No impact / 0-2%	Evidence/Risk: Little-None / p(0.4-1.0)	Evidence/Risk: Weak / p(0.2-0.4)	Evidence/Risk: Partial / p(0.02-0.2)	Evidence/Risk: Strong / p(0.0-0.02)	NOTE: Impact and evidence/risk ratings should be done independently. The impact rating should estimate the effect a failure to address the specified item might have on the program. The evidence rating should specify the qualtity of evidence that has been provided, which demonstrates that the specified risk item has been satisfactorily addressed.	Risk Exposure	
	Goal 1:					**Concurrent definition of system requirements and solutions**						
	Critical Success Factor 1.1									Understanding of stakeholder needs: capabilities, operational concept, key performance parameters, enterprise fit (legacy)	4	
1	1.1(a)	○	○	○	●	●	○	○	○	At Milestone A, have the KPPs been identified in clear, comprehensive, concise terms that are understandable to all stakeholders?		No forma
3	1.1(b)	○	○	●	○	○	●	○	○	Has a CONOPS been developed showing that the system can be operated to handle both nominal and off-nominal workloads, to meet response time requirements, and generally to meet the defined KPPs?		IT system
3	1.1(c)	○	○	●	○	○	●	○	○	Has the ability of the system to meet mission effectiveness goals been verified through the use of modeling and simulation?		IT system effectiven
4	1.1(d)	●	○	○	○	○	○	●	○	Have the success-critical stakeholders been identified, their roles and responsibilities negotiated, and their needs clearly represented by the KPPs and CONOPS?		Developm Stakehold
4	1.1(e)	●	○	○	○	○	○	●	○	Have issues about the fit of the system into the stakeholders' context -- acquirers, end users, administrators, interoperators, maintainers, etc. -- been adequately explored?		Explored after syst related to different I

Reset

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SECAT Seeks Competency Evidence

That can be independently validated

		Impact				Competency/Risk					Reset
Exposure	Question #	Critical / 40-100%	Significant / 20-40%	Moderate / 2-20%	Little-No impact / 0-2%	Little-None / p(0.4-1.0)	Weak / p(0.2-0.4)	Partial / p(0.02-0.2)	Strong / p(0.0-0.02)	NOTE: Impact and evidence/risk ratings should be done independently. The impact rating should estimate the effect a failure to competently address the specified item might have on the program. The competency rating should specify the observed, historical experience and competency of the systems engineering staff on past programs with respect to the specified risk item.	Risk Exposure
Goal 1:						**Concurrent definition of system requirements and solutions**					
	Critical Success Factor 1.1									Understanding of stakeholder needs: capabilities, operational concept, key performance parameters, enterprise fit (legacy). Evidence of ability to analyze strengths and shortfalls in current-system operations via:	4
4	1.1(a)	◉	○	○	○	○	○	◉	○	Participatory workshops, surveys, focus groups?	
4	1.1(b)	○	◉	○	○	○	◉	○	○	Operations research techniques: operations data collection and analysis?	
3	1.1(c)	○	○	◉	○	○	◉	○	○	Mission effectiveness modeling and simulation?	
3	1.1(d)	○	◉	○	○	○	○	◉	○	Prototypes, scenarios, stories, personas?	
4	1.1(e)	○	◉	○	○	○	◉	○	○	Ethnographic techniques: Interviews, sampled observations, cognitive task analysis?	

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SE Effectiveness Measurement Methods Used

- NRC Pre-Milestone A & Early-Phase SysE top-20 checklist
- Services Probability of Program Success (PoPS) Frameworks
- INCOSE/LMCO/MIT Leading Indicators
- Stevens Leading Indicators (new; using SADB root causes)
- USC Anchor Point Feasibility Evidence progress
- UAH teaming theories
- NDIA/SEI capability/challenge criteria
- SISAIG Early Warning Indicators/ USC Macro Risk Tool

Additional Personnel Competency Sources

ASN (RD&A), Guidebook for the Acquisition of Naval Software-Intensive Systems, Version 1.0, September 2008

L. Bass et al., *Models for Evaluating and Improving Architecture Competence*, CMU/SEI-2008-TR-006, April 2008

INCOSE Systems Engineering Handbook, INCOSE-TP-2003-002-03.1, August 2007

ODNI, Subdirectory Data Collection Tool: Systems Engineering, 2008.

R. Pew and A. Mavor, *Human-System Integration in the System Development Process: A New Look*, National Academies Press, 2007.

C. Williams and M. Derro, *NASA Systems Engineering Behavior Study,* NASA Office of the Chief Engineer October 2008.

Initial EM Coverage Matrix

SERC EM Task Coverage Matrix V1.0

	NRC	Probability of Success	SE Leading Indicators	LIPSF (Stevens)	Anchoring SW Process (USC)	PSSES (U. of Alabama)	SSEE (CMU/SEI)	Macro Risk Model/Tool
Concept Dev								
Atleast 2 alternatives have been evaluated	X			x	x	x (w.r.t NPR)	(x)	
Can an initial capability be achieved within the time that the key program leaders are expected to remain engaged in their current jobs (normally less than 5 years or so after Milestone B)? If this is not possible for a complex major development program, can critical subsystems, or at least a key subset of them, be demonstrated within that time frame?	X		(x)	x	x (5 years is not explicitly stated)		(x) (seems to be inferrable from the conclusions)	(x) (implies this)
Will risky new technology mature before B? Is there a risk mitigation plan?	x	x	x		(x)		x	x
Have external interface complexities been identified and minimized? Is there a plan to mitigate their risks?	x		x		x	x	x	x
KPP and CONOPS								
At Milestone A, have the KPPs been identified in clear, comprehensive, concise terms that are understandable to the users of the system?	x	(x)	x	(x)	x (strongly implied)	(x) (implied)	x	x
At Milestone B, are the major system-level requirements (including all KPPs) defined sufficiently to provide a stable basis for the development through IOC?	x	x	(x)	x	x	(x)	(x) (There is no direct reference to this but is inferrable)	x
Has a CONOPS been developed showing that the system can be operated to handle the expected throughput and meet response time requirements?	x	x	(x)	(x)	x	(x) (there is a mention of a physical solution. That's the closest in this regard)	x	x

Legend:
x = covered by EM
(x) = partially covered (unless stated otherwise)

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Personnel Competency: Commonality of Goal Frameworks

SERC EM Framework	NDIA Personnel Competency FW	SEI Architect Competency FW
Concurrent Definition of System Requirements & Solutions	Systems Thinking	Stakeholder Interaction
System Life Cycle Organization, Planning, Staffing	Life Cycle View	Other phases
Technology Maturing and Architecting	SE Technical	Architecting
Evidence-Based Progress Monitoring & Commitment Reviews	SE Technical Management	Management
Professional/ Interpersonal (added)	Professional/ Interpersonal	Leadership, Communication, Interpersonal

Example Personnel Competency Questions

1. Concurrent Definition of System Requirements & Solutions
1.1 Understanding of stakeholder needs: Capabilities, Operational Concept, Key Performance Parameters, Enterprise fit (legacy). Evidence of ability to analyze strengths and shortfalls in current-system operations via: **a. Participatory workshops, surveys, focus groups?** **b. Operations research techniques: operations data collection and analysis, modeling?** **c. Prototypes, scenarios, stories, personas?** **d. Ethnographic techniques: Interviews, sampled observations, cognitive task analysis?**
1.2 Concurrent exploration of solution opportunities; Analysis of Alternatives for cost-effectiveness & risk (Measures of Effectiveness). Evidence of ability to identify and assess alternative solution opportunities via experimentation and analysis of: **a. Alternative work procedures, non-materiel solutions?** **b. Purchased or furnished products and services?** **c. Emerging technology?** **d. Competitive prototyping?**

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Pilot Feedback Highlights

- Primarily useful during early stages
  - SEPAT: Tech Development, 60%; System Development, 100%
  - SECAT: Tech Development, 50%; System Development, 75%
  - Between "Very Effective" and "Somewhat Effective"
- Too many Red and Yellow risks
  - Rating scales reworked
- Overly DoD-specific (NASA responder)
- Need versions for different domains, project types
  - Quick-response/agile; legacy-driven; KPP-driven; sea; space; …
- Make question format uniform across SEPAT and SECAT

EM Processes and Tools Help Enable MDAP Transformation

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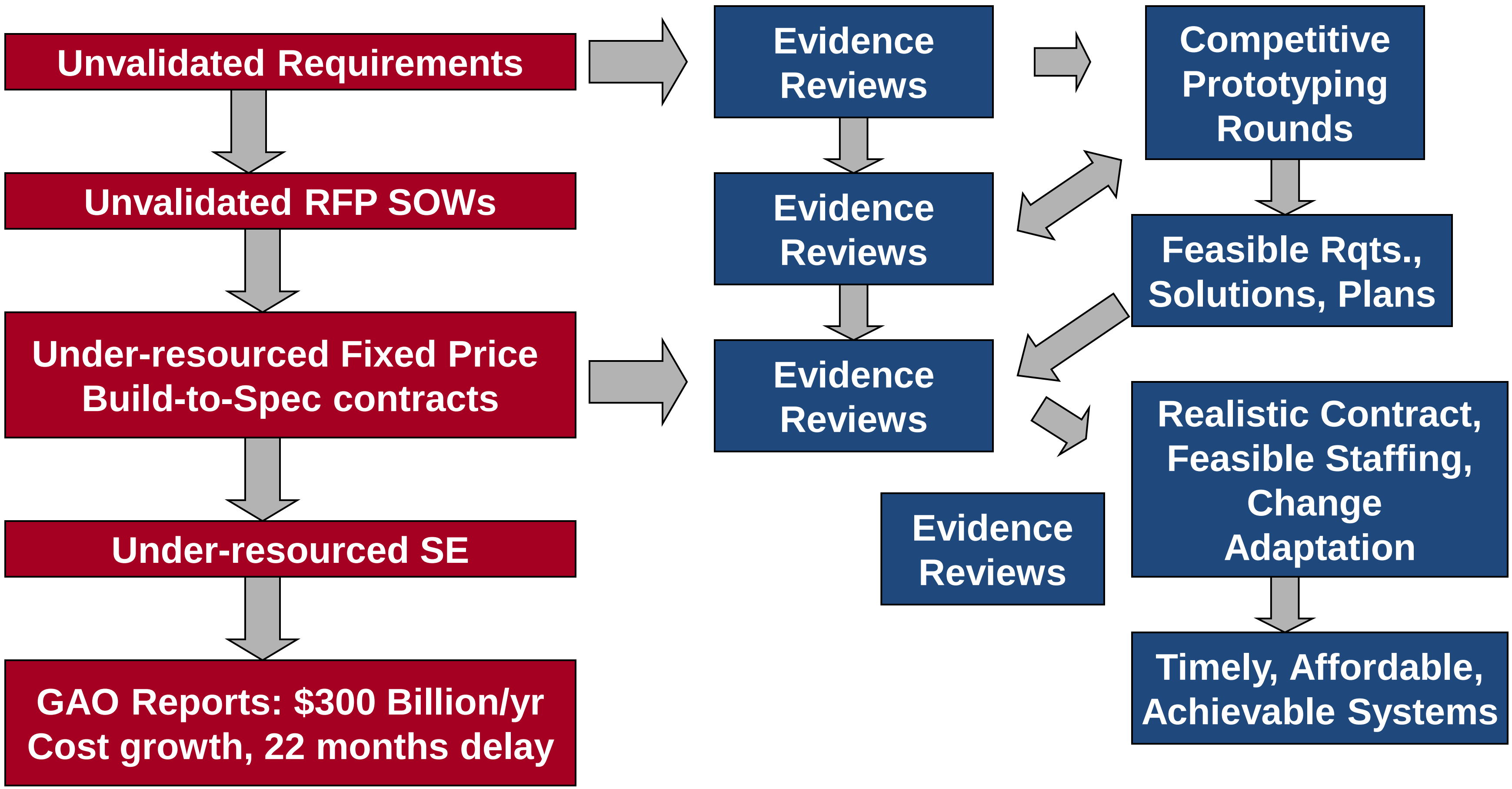
Implements spirit of July 2009 Augustine BENS Report

Adversarial Mistrust | Collaborative Trust-and-Verify



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Project and Tool Status and Plans

- We have two tools for evaluating systems engineering (SE) effectiveness in the definition and development stages of Major Defense Acquisition Programs
  - SE Performance Assessment Tool (SEPAT)
  - SE Capability Assessment Tool (SECAT)
  - Based on analysis and synthesis of major sources of DoD SE EMs
  - Including concepts of operation for project usage, sponsor-developer coordination, SE EM knowledge base development
- We have piloted the tools on (7 now; over 12 expected) projects
  - And evaluated them with respect to the ODDR&E-SSE Systemic Analysis Database (SADB)
  - Feedback mostly positive; some good improvement suggestions
- We are incorporating some suggestions and have drafted plans for followon improvement efforts

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Bottom Line Message

- SE shortfalls are a major source of DoD system acquisition problems
  - Systemic Analysis Database analysis results
- SE EM shortfalls are a major source of SE effectiveness problems
  - You can't control what you can't measure
- The SECAT and SEPAT tools enable a measurement-driven SE process
  - Via negotiated MDA-acquirer-developer EM-based approach
- EM-driven SE improvement has high ROI for MDAPs
  - ROI varies with system size, criticality, volatility
- The SERC SE EM tools are approaching general-use maturity
  - Core tools are in the TRL 5-6 (alpha-beta test) range
  - Domain/life cycle extensions, risk summaries, mitigation guidance TBD
- Draft plan to mature, extend, transition technology in work
  - Looking for collaborators, early adopters interested in reducing their overrun and delivery shortfall rates

References

ASN (RD&A), Guidebook for the Acquisition of Naval Software-Intensive Systems, Version 1.0, September 2008

N. Augustine et al., *Getting to Best: Reforming the Defense Acquisition Enterprise*, Business Executives for National Security Report, July 2009, http://www.bens.org/mis_support/Reforming the Defense.pdf

L. Bass et al., *Models for Evaluating and Improving Architecture Competence*, CMU/SEI-2008-TR-006, April 2008

B. Boehm and J. Lane, "Guide for Using the Incremental Commitment Model (ICM) for Systems Engineering of DoD Projects, v.0.5," USC-CSSE-TR-2009-500, http://csse.usc.edu/csse/TECHRPTS/

INCOSE Systems Engineering Handbook, INCOSE-TP-2003-002-03.1, August 2007

P. Kaminski et al., *Pre-Milestone A and Early-Phase Systems Engineering*, National Academies Press, 2008.

ODNI, Subdirectory Data Collection Tool: Systems Engineering, 2008.

R. Pew and A. Mavor, *Human-System Integration in the System Development Process: A New Look*, National Academies Press, 2007.

C. Williams and M. Derro, *NASA Systems Engineering Behavior Study,* NASA Office of the Chief Engineer October 2008.

Backup Charts

The SERC EM Team

- USC: Barry Boehm, Dan Ingold, Winsor Brown, JoAnn Lane, George Friedman
- Fraunhofer-Maryland: Kathleen Dangle, Linda Esker, Forrest Shull
- Stevens: Rich Turner, Jon Wade, Mark Weitekamp
- U. Alabama-Huntsville: Paul Componation, Sue O'Brien, Dawn Sabados , Julie Fortune

OSD Sponsor Representative: Chris Miller

Summary of Major Scope Decisions

Decision	Rationale
MDAP vs. multi-type EMs	SE shortfalls a major MDAP problem
Core vs. all-domain EMs	Avoid numerous inapplicable EMs
Ease of tailoring, extension	Enable special-community tailoring
Cover SE functional performance and personnel competency	Sponsor priority
Rate both degree of impact and degree of satisfaction evidence	Relation to risk exposure RE=P(L)*S(L), ease of tailoring out zero-impact questions
Hierarchical goal - critical success factor – question framework	Ease of use, understanding; compatibility with related frameworks
Compatibility with INCOSE Leading Indicators	Complementary coverage: continuous vs. discrete; quantitative vs. qualitative
Framework and tools	Early SERC tangible product
Pilot use and evaluation	Evidence of strengths and shortfalls
Initial focus on project assessment vs. practice ROIs	ROI data unavailable; could be generated via tool use

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Magnitude of MDAP Problem

Analysis of U.S. Defense Dept. Major Defense Acquisition Program Portfolios

Fiscal 2009 dollars

Portfolio size	2003	2007	2008
Number of programs	77	95	96
Total planned commitments	$1.2 trillion	$1.6 trillion	$1.6 trillion
Commitments outstanding	$724.2 billion	$875.2 billion	$786.3 billion
Portfolio indicators			
Change to total RDT&E* costs from first estimate	37%	40%	42%
Change to total acquisition cost from first estimate	19%	26%	25%
Total acquisition cost growth	$183 billion	$301.3 billion	$296.4 billion
Share of programs with 25% increase in program acquisition unit cost growth	41%	44%	42%
Average schedule delay in delivering initial capabilities	18 months	21 months	22 months

Source: U.S. Government Accountability Office

Research, Development, Testing & Evaluation

Operational concepts for EM tool usage

- EM tools used to reach sponsor-performer consensus on way forward
  - Via EM-based risk assessments
- Three scenarios
  - Milestone A: Acquirer and Milestone Decision Authority (MDA)
    - MDAP and non-MDAP cases
  - Contract Negotiation: MDAP Acquirer and Developer
  - Project Execution: MDAP Developer Manager and Performers

Scenario 1. Acquirer and MDA at Milestone A

- Acquirer submits proposed acquisition plan to MDA with SEPAT, SECAT ratings and risk mitigation approaches
- MDA has independent experts review SEPAT, SECAT ratings
  - Major finding: Analysis of Alternatives rated No Impact, no risk
  - MDA asks Acquirer for AoA impact rationale
- Acquirer response: Case 1
  - Capability is needed quickly for limited but critical use
  - Evidence is available that Alternative A solution is sufficient
  - MDA response: Rationale is sufficient. OK to proceed
- Acquirer response: Case 2
  - DARPA demo has shown proof of principle. All that is needed is to implement it for the general case
  - MDA response: No evidence of scalability, ability to handle degraded battle conditions. Resubmit using Competitive Prototyping

Competitive Prototyping Benefits Example – 4:1 RPV

- Total Commitment
  - Agent technology demo and PR: Can do 4:1 for $1B
  - Winning bidder: $800M; PDR in 120 days; 4:1 capability in 40 months
  - PDR: many outstanding risks, undefined interfaces
  - $800M, 40 months: "halfway" through integration and test
  - 1:1 IOC after $3B, 80 months

- CP-based Incremental Commitment [number of competing teams]
  - $25M, 6 mo. to VCR [4]: may beat 1:2 with agent technology, but not 4:1
  - $75M, 8 mo. to ACR [3]: agent technology may do 1:1; some risks
  - $225M, 10 mo. to DCR [2]: validated architecture, high-risk elements
  - $675M, 18 mo. to IOC [1]: viable 1:1 capability
  - 1:1 IOC after $1B, 42 months

Scenario 2. Acquirer-Developer

- Acquirer tailors SEPAT, SECAT to project specifics
  - Domain and project extensions
  - Question impact/priority ratings
- Acquirer coordinates SEPAT, SECAT usage with developer
  - As mutual instruments for monitoring SE effectiveness
  - At major milestones and project reviews
  - Portion of award fee based on review of evidence
- Developer analyzes implications for project SE effort
  - Options on evidence production, associated costs
- Developer, Acquirer converge on options
  - And adjustments to questions, impact ratings, SE budgets, milestone content, contract provisions

Scenario 2 Example

- Acquirer specifies CSF 1.2(d) to have Critical impact:
  - Have the claimed quality of service guarantees been validated?
- Winning competitive prototyping developer responds:
  - This would be incompatible with your proposed contract, which ties our System Functional Requirements Review milestone progress payments and award fees to specifying functionality. Our proposed SE plans and budgets don't cover doing QoS guarantees by then.
- Acquirer responds:
  - Thanks. The contract clearly undercuts our intent to do evidence-based concurrent engineering, and sets us up for late overruns. We'll redo it and your SE plans and budgets. Next time, we'll address contracting compatibility earlier.

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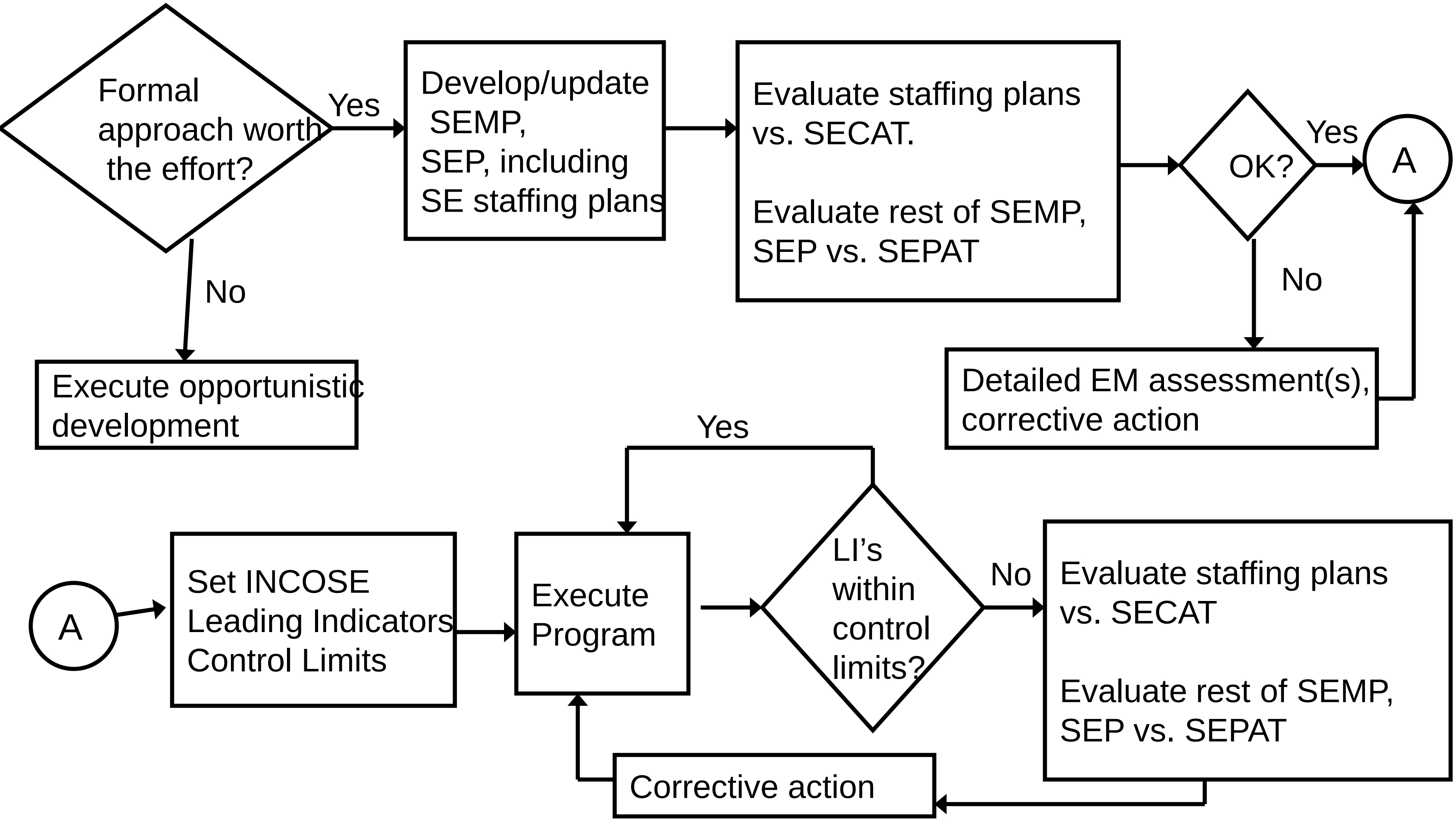
Scenario 3. Project EM

- Primary responsibilities, authority, accountability (RAA)
  - Primary assessment consumers: Persons with management responsibility for program results
    - Contractor PM, DoD acquirer PM/PEO, oversight personnel
  - Primary assessment conveners, monitors: Chief Engineers, Chief Systems Engineers
  - Primary assessors: Independent experts

Project SysE EM Operational Concept

(for each stage of system definition and development)



First-Order EM Evaluation Process

- Examine revised list of candidate EMs
  - Use NRC early SE checklist as concise starting point
  - Identify similar key elements of other EMs
  - 45x8 cross product of EMs and characteristics
- Evaluate EMs against identified criteria
  - Preliminary "quick-look" evaluation by USC
  - Evaluation by originators, where possible
  - Follow-up with independent evaluation by team
- Review coverage/commonality of elements
  - Incorporate suggested additions (now 51 items)

Structuring the 51 EM Elements

Systems Engineering Effectiveness Measurement Proposed New Framework	SEPP-Guide-Based Eval. Framework	SISAIG/ Macro Risk Framework	Coverage Matrix Items
1. Concurrent Definition of System Requirements & Solutions			
1.1 Understanding of stakeholder needs: Capabilities, Operational Concept, Key Performance Parameters, Enterprise fit (legacy)	1.1, 1.4, 3.1	1.1, 1.4	5, 7, 22, 36, 37
1.2 Concurrent exploration of solution opportunities; AoA's for cost-effectiveness & risk (Measures of Effectiveness)	4.1, 4.2	1.2	1, 14, 26, 27, 28
1.3 System scoping & requirements definition (External interfaces; Memoranda of Agreement)	1.2, 1.4	3.2	4, 6, 13, 50
1.4 Prioritization of requirements & allocation to increments	1.3	1.5	2, 11, 31

Steps for Developing Feasibility Evidence

A. Develop plans for developing work-products/artifacts

B. Determine most critical feasibility assurance issues
   - Based on SEPAT, SECAT question impact/priority ratings

C. Evaluate feasibility assessment options
   - Cost-effectiveness, rework avoidance , risk reduction ROI
   - Tool, data, mission scenario availability

D. Select options, develop feasibility assessment plans

E. Prepare evidence development plans and earned value milestones

"Steps" denoted by letters rather than numbers to indicate that many are done concurrently

Steps for Developing Feasibility Evidence *(cont.)*

F. Begin monitoring progress with respect to plans
   - Also monitor project/technology/objectives changes and adapt plans

G. Prepare evidence-generation enablers
   - Assessment criteria
   - Parametric models, parameter values, bases of estimate
   - COTS assessment criteria and plans
   - Benchmarking candidates, test cases
   - Prototypes/simulations, evaluation plans, subjects, and scenarios
   - Instrumentation, data analysis capabilities

H. Perform pilot assessments; evaluate and iterate plans and enablers

I. Assess readiness for SEPAT-SECAT evidence assessment
   - Evidence shortfalls identified as risks and covered by risk mitigation plans
   - Proceed to Milestone Review if ready

J. Hold Milestone Review when ready; adjust plans based on review outcomes

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SE Performance, Competency are Major Sources of OSD/AT&L Systemic Analysis Negative Findings

1 Technical process (35 instances)

- V&V, integration, modeling&sim.

2 Management process (31)

3 Acquisition practices (26)

4 Requirements process (25)

5 Competing priorities (23)

6 Lack of appropriate staff (23)

7 Ineffective organization (22)

8 Ineffective communication (21)

9 Program realism (21)

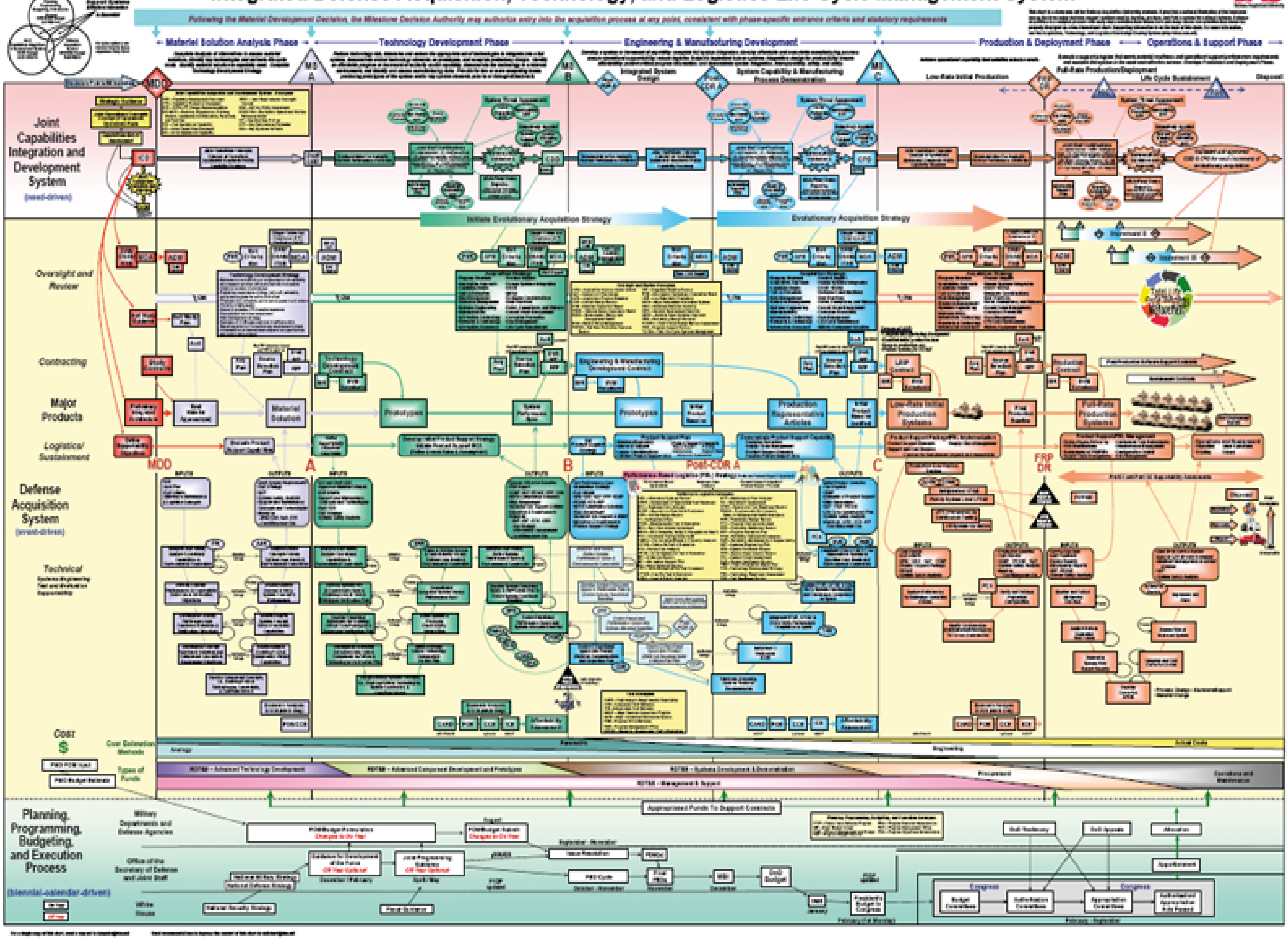
10 Contract structure (20)

Systems Engineering and Logistics: Gunners Restraint

Systems Engineering Conference
29 October 2009

Michelle Bowen
Chief System Engineer for Logistics

Integrated Defense Acquisition, Technology, and Logistics Life Cycle Management System



Agenda

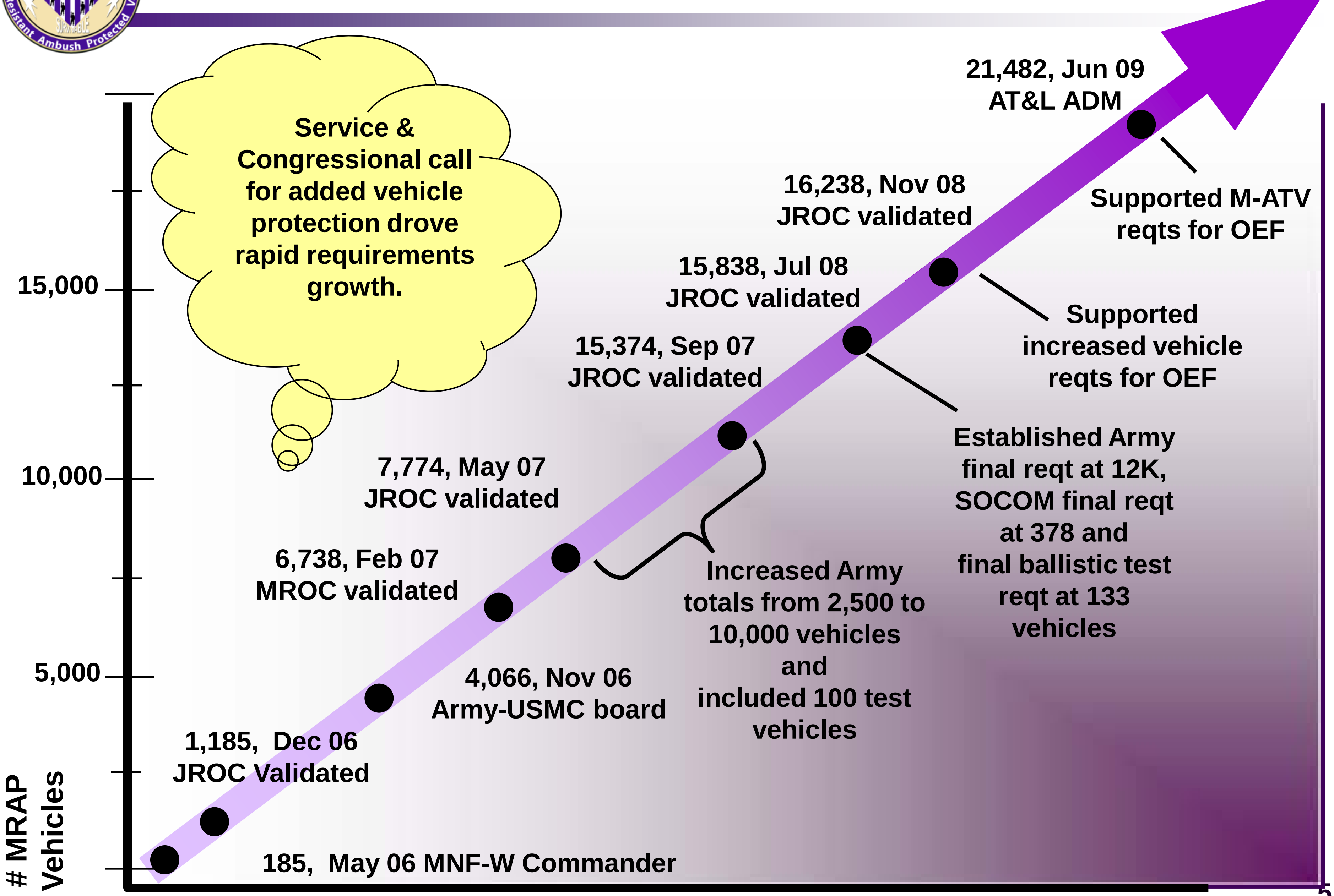
- MRAP Overview
- Systems Engineering and Logistics
- Implementation of Systems Engineering to save lives: Gunners Restraint System (GRS)

Tactical Response

- Change in enemy tactics generated an urgent Warfighter need for:
  - Mine Resistant Ambush Protected Vehicle
  - Large quantities

- MRAP Program is the response to this urgent need
  - Unprecedented effort
  - Unprecedented speed
  - Unprecedented Gov / Industry Teamwork

Operational Demand Signal



MRAP Vehicle Variants

- To meet the requirement as quickly as possible 5 IDIQ contracts were awarded.

- Requirements were written to the capability industry had at this time

GDLS RG-31 CAT I/EM

BAE SOCOM (RG-33) CAT I /Plus

Navistar MaxxPro CAT I /Plus/Dash

FPI Cougar CAT I/Plus

BAE-TVS Caiman CAT I/ Plus

BAE RG-33L CAT II/Plus

BAE HAGA CAT II/Plus

FPI Cougar CAT II/Plus

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Systems Engineering and Logistics

- As we support the operations in OIF/OEF it is critical that we continue to integrate logistics into our SE process closely

- Specific processes are in place bringing logistics in at the front end of engineering decisions

  - Requirements Decomposition
  - Design
  - Feedback from the Warfighter

Systems Engineering and Logistics Cannot Be Separated

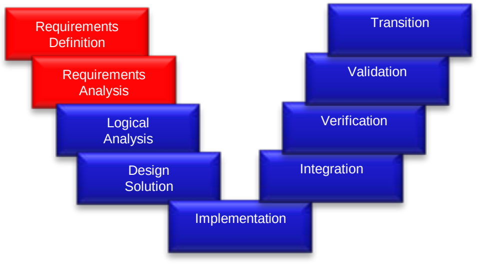
MRAP Integrated SE and Logistics

- Only PdM with a Chief Systems Engineer for Logistics
- PdM Logistics has implemented a planning cell that uses SE processes to accomplish each levied requirement
  - Integrated Master Schedule/Critical Path analysis
  - Risk analysis and Mitigation Strategies
  - Roles and Responsibilities
  - End to end Life Cycle Analysis (example: follow-on roll over trainers)
- Logistics is a heavily weighted factor in the requirements management process to include commonality, install level and theater of operation

GRS SE/LOG that Saves Lives

❖ Requirement/Requirements Analysis:

- **MRAP vehicles are more prone to rollover due to their weight and higher center of gravity**
  - **Gunners were being thrown from the vehicle due to rollover**
- **Sept. 20, 2008 during a visit to Bagram Air Field in Afghanistan Secretary of the Army Pete Geren was informed that the MRAP didn't have a gunners restraint like other tactical vehicles.**
  - **All MRAPs received a GRS**
  - **All GRSs were fielded by February 1 2009**

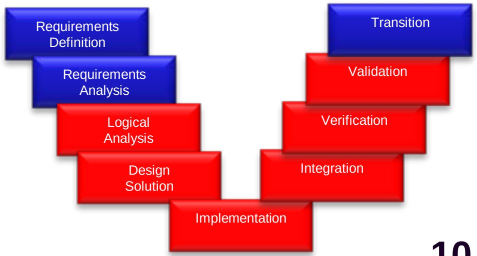


Design/Integration/Verification/Validation

- 24 September 2008 RDECOM was tasked to design a GRS for MRAP in 72 hours.
  - Integration of the existing gunners restraint of the BAE M1114
  - Systematic approach to designing the minimum amount of A-Kits for 9 different variants.
  - No CAD of any of the MRAP vehicles.

- Design Completed and User Jury conducted at TARDEC before sending to test at ATC

- ILSC tech writer sitting side by side with designers to produce install instructions and parts and special tools list.

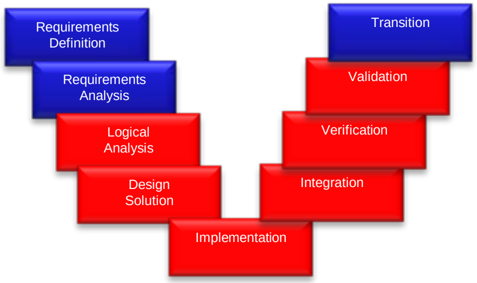


Design/Integration/Verification/Validation, cont.

- Upon arrival at ATC, redesign was required due to a human factors issue

- All parties pulled together to analyze the issue, redesign/update the drawings and prototype the part for test over night.

- Testing completed on 3 variants by Sept 27 allowing production to begin at Rock Island Arsenal and Blue Grass Army depot. The remaining variants following closely behind.



Design/Integration/Verification Completed in less than 72 hours

GRS Timeline

- 20 SEP 08 — Sec. of the Army travels to OEF and notices MRAPs without GRS
- 24 SEP 08 — TARDEC Tasked to design GRS kits for MRAP in 72 Hours
- 26 SEP 08 — User Jury at ATC with CSMs, redesign and prototype manufactured.
- 27 SEP 08 — Integration and testing of 3 GRS kit Complete
- 29 SEP 08 — Concept of install/distribution established with both theaters
- 2 OCT 08 — First kits fielded to units in OEF
- OCT-DEC 08 — Production of 800 per week continues as do installs in both OEF and OIF
- 31 DEC 08 — GRS delivery to units for install on all MRAPs in OEF Complete
- 9 JAN 09 — GRS delivery to units for install on all MRAPs in OIF Complete
- 1 FEB 09 — Frago Released by MNC-I stating all MRAPs without GRS are deadlined

Over 9,500 GRS Systems Delivered in 110 Days

BAE SYSTEMS

Summary

- MRAP's use of systems engineering principles in logistics lead to fielding MRAP as quickly as possible.
- Integrating Logistics into the SE process early is critical to support the Warfighter

MRAP “the Ultimate Team Sport”

Questions?

Engineering
Process
Improvement

Lean Advancement Initiative

Enhancing Systems Engineering Competencies in the Enterprise

29 October 2009

LOCKHEED MARTIN

Garry Roedler

Objective of Presentation

- Communicate the elements of the Engineering Professional Development program for Systems Engineering at Lockheed Martin.

Vision

A comprehensive set of skills and a curriculum that is integrated across disciplines to provide the foundation for engineering professional development and qualification, and enable flexible career paths.

A broad program with multiple components to affect the development of engineers – not just a set of courses

Corporate Technical Learning Council

Role

- Integrates the efforts of all Business Areas and Corporate Organizations involved with technical learning

Function

- Communication and coordination forum
- Promotes teamwork and cooperation

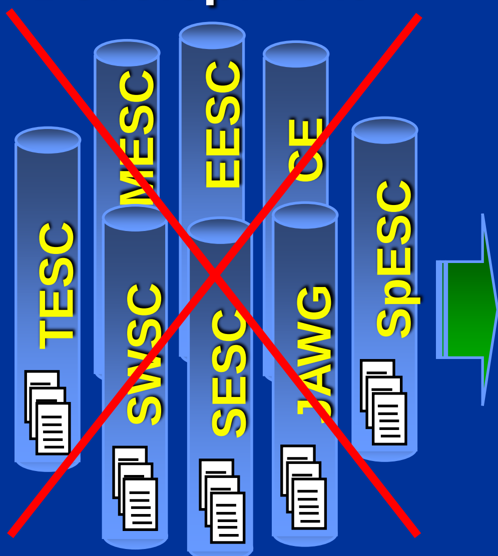
Goals

- Reach more of the workforce
- Improve learning effectiveness
- More effective and motivated workforce
- Higher retention levels
- Greater recruiting discriminators

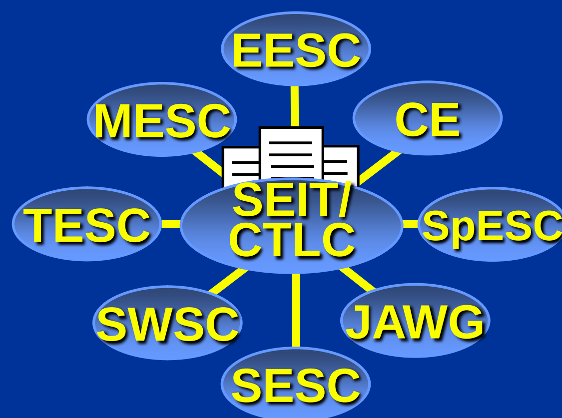
The CTLC integrates multiple corporate entities previously operating independently on technical learning initiatives

Integration Drivers

- CTLC identified needs and set vision for Engineering Professional Development
  - Need to address eroding technical base and preserve knowledge
- EPD VSM focused on overall strategy for Engineering Professional Development



From "Cylinders of Excellence" with Separate Assets to …



Integrated Approach Using a Common Set of Assets

Objectives

- Same "look and feel"
- Allow identification of common Skills and Training needs
- Promote consistent understanding of concepts, terms, etc.
- Facilitate cost-effective course development via common courses, where applicable
- Framework for common engineering needs along with discipline specific needs

A comprehensive approach to skills integration

Integrated Approach to Address Skills, Training, and Career Path

Innovative Learning Team

Recommended delivery method(s) for courses

Cours

- **Integrated Curriculum**
  - ➢ Identifies and defines common courses
  - ➢ Includes discipline unique and specialization courses
  - ➢ Identifies applicability of courses to disciplines/roles
  - ➢ Facilitates greater leverage among disciplines
  - ➢ Curriculum includes the following information about each course:
    - Description/abstract
    - Annotated outlines
    - Learning objectives
    - Audience
    - Pre-requisites
    - Level of Course

- **Single Development/ Qualification Guide**
  - ➢ Single approach
  - ➢ Common terminology
  - ➢ Appendices for supplemental information for each discipline/ role
  - ➢ Provides for single communication effort

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Curriculum Development

BA/BU Needs & Requirements
Product & Implementation Plans

BA/BU Interface Team

Er
requirements

path

Career Path Development

Engineering Development and Qualification Program (EDQP)

- Framework to develop, verify and recognize the knowledge, experience and capabilities of practicing engineers
  - Establishes common expectation of the specific engineering capabilities
  - Facilitates technical development and career path planning of engineers (including those new to the discipline)
  - Defines capabilities and experiences for use by HR & leaders to develop staffing plans/execute staffing
- Builds on documented skills and curriculum
- Includes multiple stages of development

Key EDQP Concepts

Define
Role

Identify L&D
Direction

Encourage Individual
Responsibility
for Development

Create a Tailorable
Framework

Provide Enabling
Resources

Aligning Individual Career Goals with Business Needs

Key EDQP Elements

Experience/OJT
- Discipline & domain
- Successful demonstration of skills

Training/Education
- Consistent foundation knowledge per curriculum

Coaching
- First receiving coaching
- Later providing coaching

Mentoring
- First as Mentee
- Later as Mentor

Basis of Qual Criteria

Skills Portfolio (Competencies)

BA/BUs Implement Tailored Program

Sustainment

Qualification Stage Criteria per Role

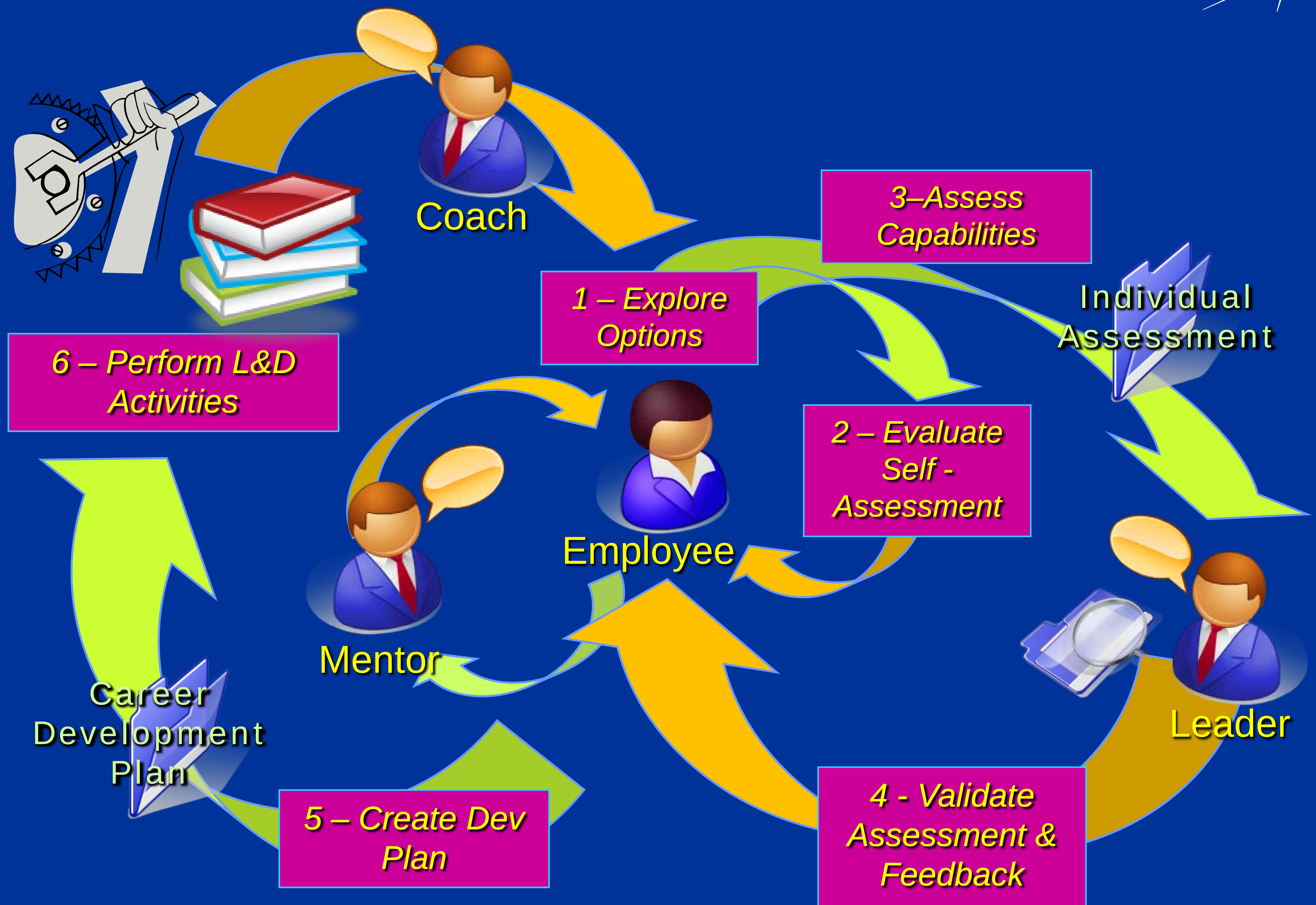
Assessment

Con-Ops & Review Board

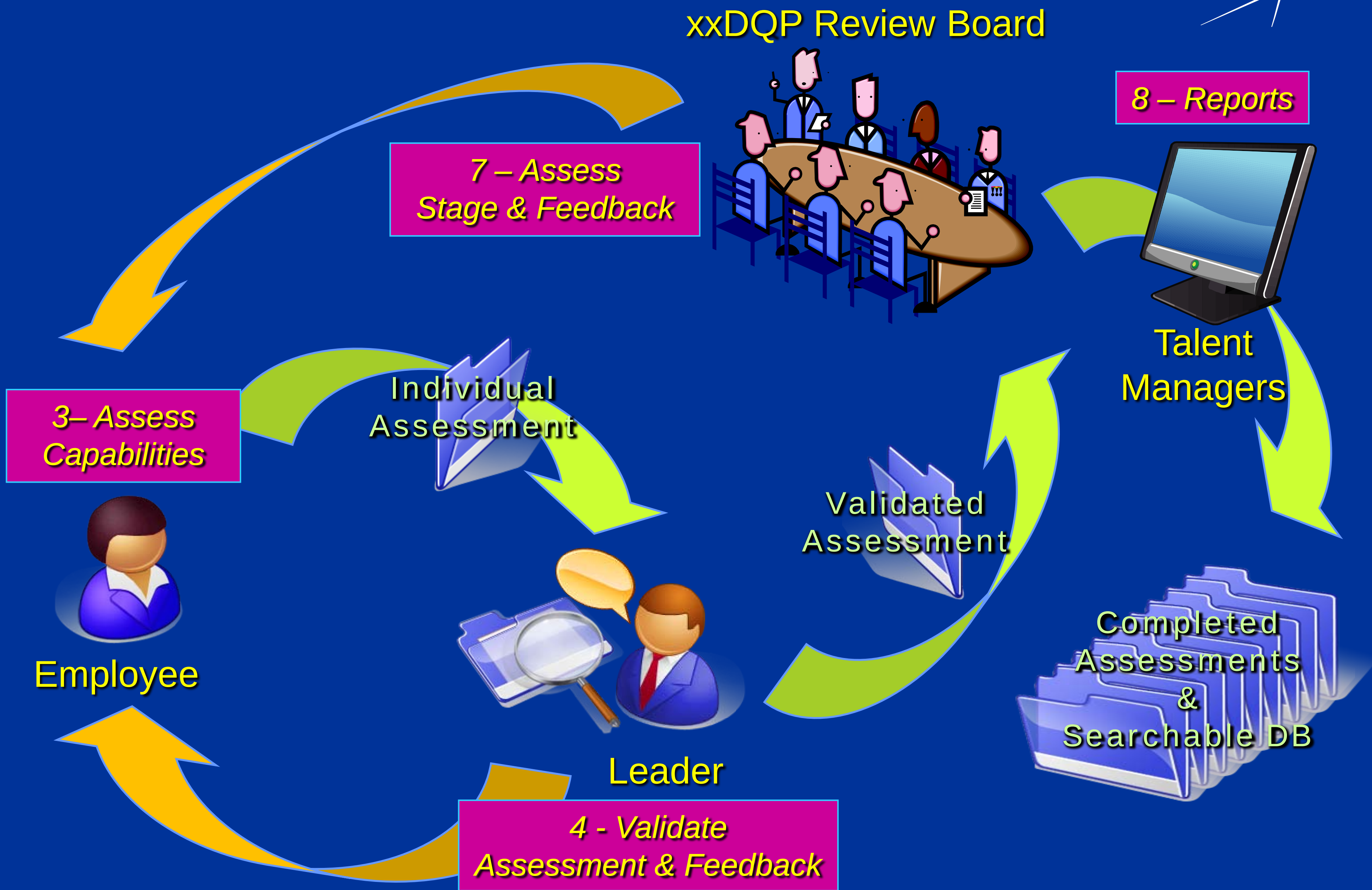
Acknowledgement of Qualification Rating

A Systematic Personnel Development Approach

EDQP Development Con-ops



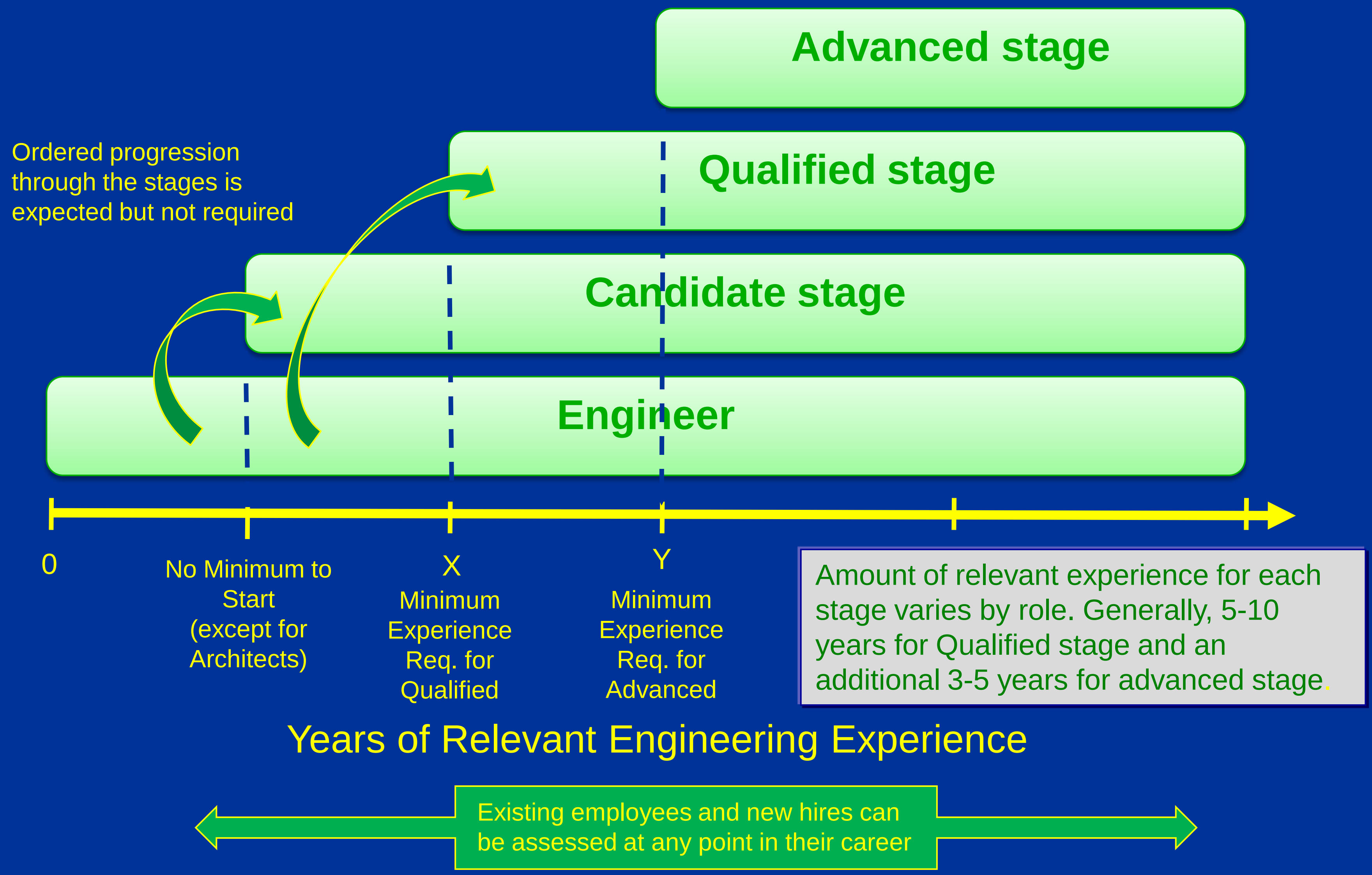
EDQP Qualification Con-ops



EDQP Stages of Acknowledgement

- **Candidate**
  - Interest in career in the subject discipline, but experience or skill level requirements for for Qualification not yet met.
  - Application for EDQP of the subject discipline has been accepted.
  - Formalizes career development intent and planning.
  - Pre-requisites achieved per documented requirements (in 270-17).
- **Qualified**
  - An individual who has met or exceeds the criteria specified for the Qualified Stage in the specific discipline.
  - The minimum common criteria to attain the designation of “Qualified” is documented for each discipline in the appendices of 270-17.
  - The business unit may include additional criteria (e.g., to address domain or business unit specific needs) in their implementation of the program.
- **Advanced**
  - An individual who has met or exceeds the criteria specified for the Advanced stage in the specific discipline.
  - The minimum common criteria to attain the designation of “Advanced” is documented for each discipline in the appendices of 270-17.
  - The business unit may include additional criteria (e.g., to address domain or business unit specific needs) in their implementation of the program.

Notional Development Timeline



Other Information in EDQP

- EDQP Concept of Operations
- Eligibility
  - Open to all, except where pre-requisites are noted
- Successful completion of training
  - Testing is on course-by-course basis per learning objectives
- Request for Acceptance of Equivalent Learning or Development
  - No blanket waivers or grandfathering
  - Provide rationale for equivalency with objective evidence
- Reciprocity
  - Accepted by receiving BU
  - Employee responsible to obtain domain skills per BU needs
- Renewal
  - Business Unit decision
  - Typically 3-5 years with additional learning and experience requirements

Skill Set Matrix

- Documents the skills required for given disciplines or roles
- Includes skill categories, skill sets, skills, sub-skills and appropriate classifications
  - ***Skill Category*** – High-level grouping of skill sets based on general focus
  - ***Skill Set*** – A set of skills that are related to a key objective.
  - ***Skill*** - Aptitude required for the performance of a process or life cycle activity.
  - ***Sub-skill*** - One of lower level multiple aptitudes required to perform a skill.
- Skill Sets, Skills, and Subskills are defined the discipline team for each skill category

Skills provide the basis for curriculum and development

Common Skill Categories

- Process
  - Common skills apply to all disciplines
  - Addresses organizational standard processes, standards, and tools
- Technical
  - Focused on the technical engineering processes through the life cycle
- Application/Domain/Environment (BU Specific)
  - Skills specific to the business unit domain areas
- Personal Development
  - Common set established by CTLC for all disciplines
  - Focused on the interpersonal, communication, efficiency and effectiveness, and team skills
- Management
  - Focused on the project management processes through the life cycle

Curriculum Development

- Derived from the skills to provide the educational building the skills
  - Skills→Learning Requirements→Cour iterations)
  - Maintain a mapping of skills to ses to ensure adequate coverage and su analysis
- Courses included in the c endent of any existing course
  - Defines what se to meet the LMC skill requireme
  - "Noti used to:
    - ourses (internal and external)
    - irements for development of new courses

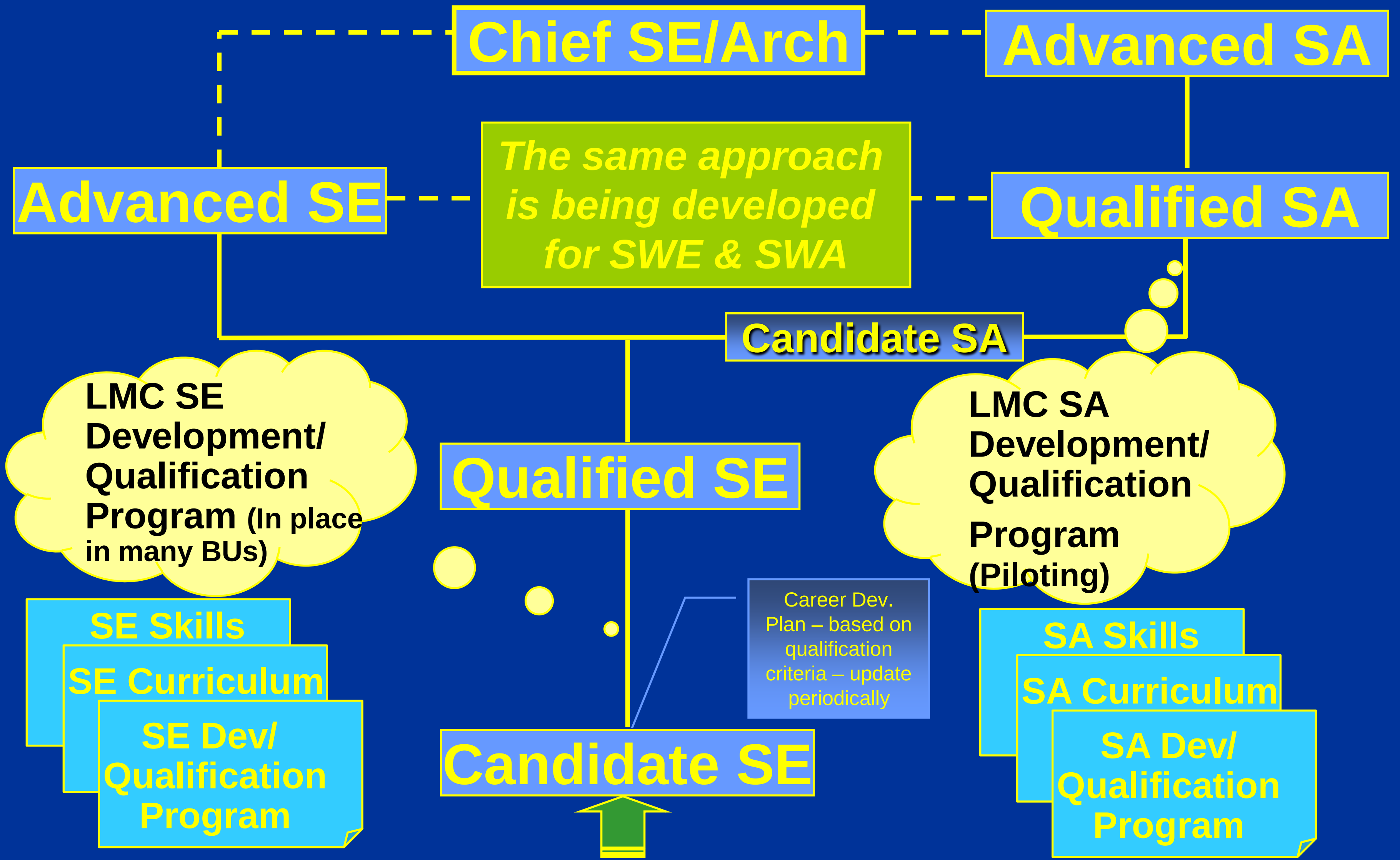
culum is based on defined skills;
dependent of existing course offerings

Strong emphasis on e-learning/self-paced to provide common training to larger audiences in a consistent, yet flexible manner while leveraging technology

Course Types

- Essential (Foundation) courses
  - Technical knowledge in a discipline needed for fundamental tasks.
- Enhancement (Supplemental) courses
  - More in-depth technical knowledge needed for more advanced tasks.
- Specialization courses
  - Technical knowledge in required only for specialized assignments in that discipline.
- Inter-discipline courses
  - Address skills in one discipline that are beneficial for successful performance in other disciplines.
- Personal Development courses
  - Address skills that enhance general professional effectiveness.
- Domain/BU Specific courses
  - Defined by the BU to meet unique needs

System Engineer and Architect Development



Continuous Improvement

- Alignment with SE competency models
  - Influence, learn from and align with efforts across industry (e.g., NDIA, UARC, INCOSE)
- Refine/improve over time
  - Monitor changes in technology, customer needs, and advancements in learning approaches
  - Incorporate lessons learned

QUESTIONS?

NDIA 12th Annual Systems Engineering Conference
The Role of Simulation to Track Mobile Assets Using Automatic Identification Systems

Swee Leong
NIST
Swee.Leong@nist.gov
301-975-5426

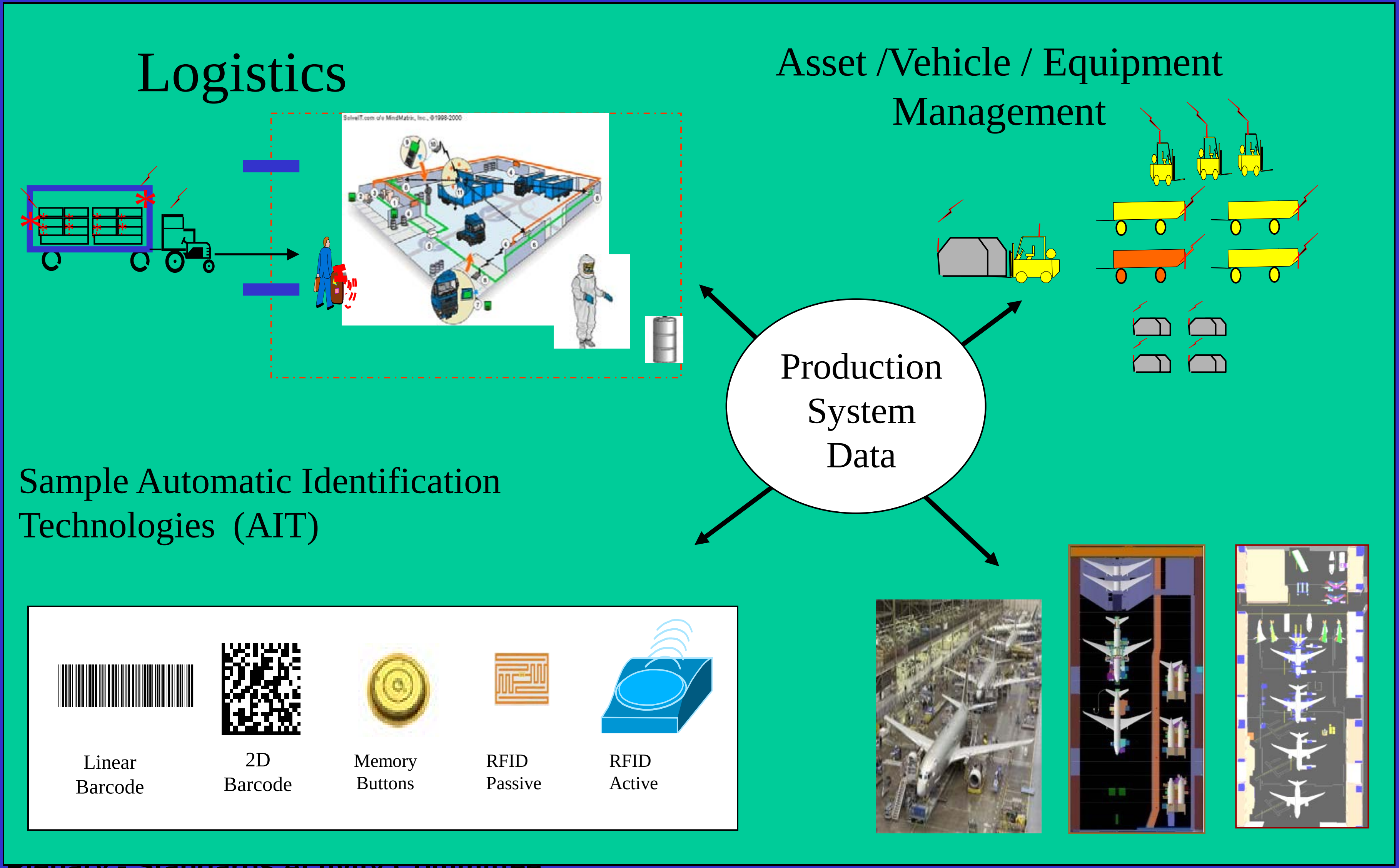
October 26-29, 2009

Introduction

- Boeing is collaborating with the National Institute of Standards and Technology (NIST) to model mobile assets for 777 and 787 final assembly operations
- Evaluations will be applied to assess the business case in the use of auto ID technologies

- NIST Core Manufacturing Simulation Data (CMSD) Information Model
- Boeing Material Handling System discrete event simulation model

A 777 Hypothetical Case



Problem Statement

get the most value out of their investments. From our survey of manufacturing multinationals, we estimate that 80 percent or more of the most global and complex companies are unable to fully exploit their global networks of customers, suppliers, manufacturing, distribution, sales, and service operations. Our analysis suggests that their performance is 50 percent lower than that of similarly large and complex companies with the capabilities to exploit more fully their global network investments.[21]

Peter, "Growing the Global Corporation," Deloitte Research, March 2005.

DARATECH, Inc.

industry update

Vol 17 Issue 4 APRIL 2005

IT for MANUFACTURING, ENGINEERING, CONSTRUCTION AND PLANT OPERATIONS

MUDDY WATERS

Lack of Interoperability Continues to Vex Manufacturing Industry; Diminishes PLM Spoils

Proliferation of Standards & Data Formats Complicate the Issue

By Tim Hickey

Over 95% of all application integration projects fail, according to a 2003 study by The Standish Group International Inc. IT staffs either significantly exceed their budgets, fall behind schedule, or fail to accomplish their goals.

Current Integration Approaches: Leading to Failure

Over 95% of all application integration projects fail, according to a 2003 study by The Standish Group International Inc. IT staffs either significantly exceed their budgets, fall behind schedule, or fail to accomplish their goals.

coupled integration direct... Occasionally, pre-built ad... connectivity to a handful of applications and data. ...but they often provide only hard-wired, bi-directional ...the IT infrastructure.

Lack of interoperability: $1B/yr to U.S. auto suppliers

$3.9B/yr in electronics

From "Developing SOA Solutions to Accommodate Variety and Change - A White Paper" by Michael Hoskins, CTO, Pervasive Software

Motivation / Issues

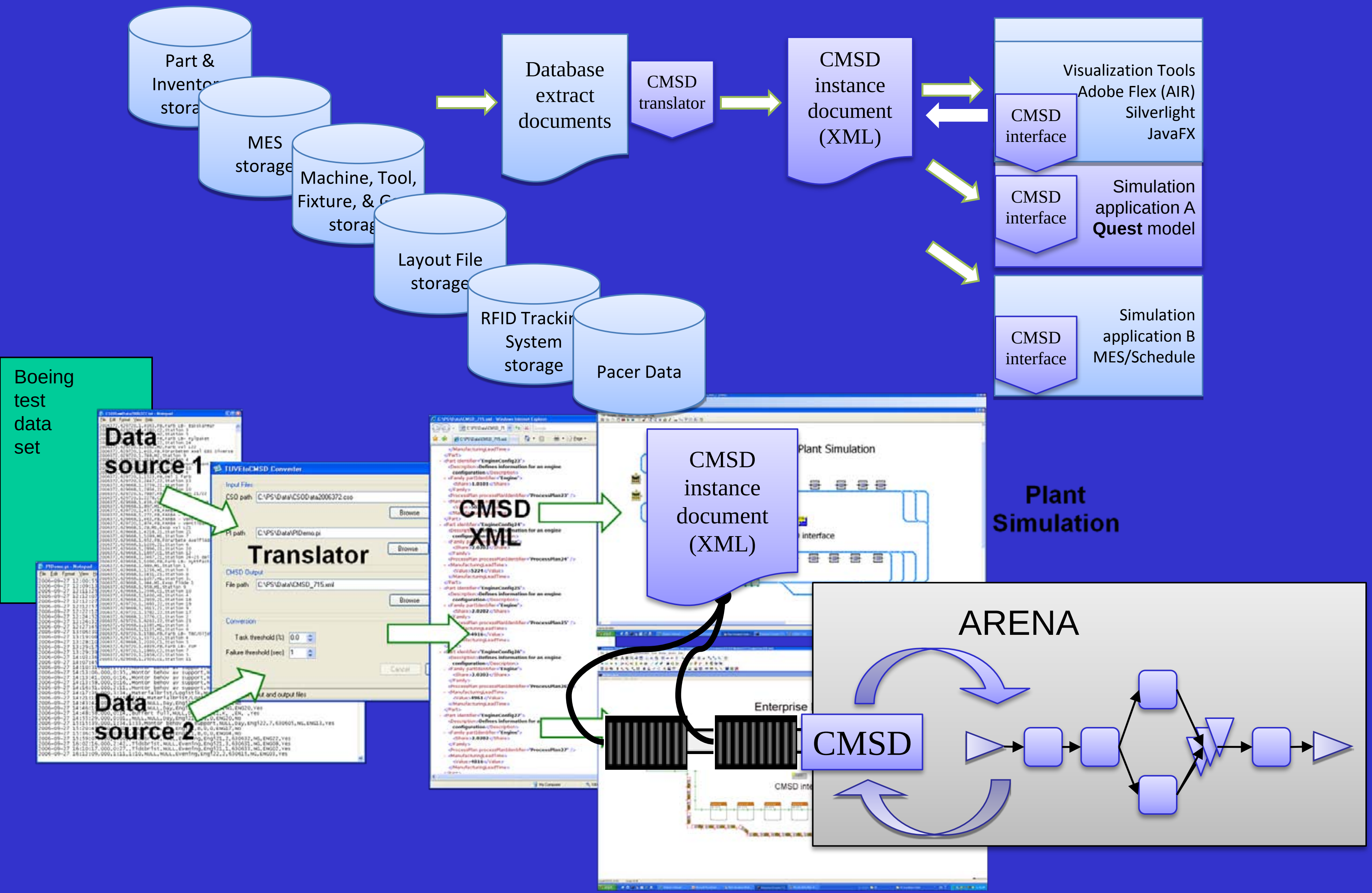
Industry

- Use visualization and simulation to analyze bottleneck and equipment downtime to increase capacity and improve throughput
- Engineers spent too much time and effort to prepare and process input data to simulation
- Engineers take too long to create simulation models

NIST

- Mission: help industry improves productivity and competitiveness with visualization, modeling and simulation
- Validate CMSD: exchange manufacturing resource data
- Require systems integration to address interoperability among manufacturing applications

A CMSD Pilot Implementation



Goal

The CMSD Information Model defines a data specification for efficient exchange of manufacturing data in a manufacturing simulation environment. The specification provides a neutral data format for integrating manufacturing applications and simulation.

- Enable data exchange between manufacturing simulation systems, other software applications, and databases
- Support the construction of manufacturing simulators
- Support testing and evaluation of manufacturing software
- Support manufacturing software application interoperability.

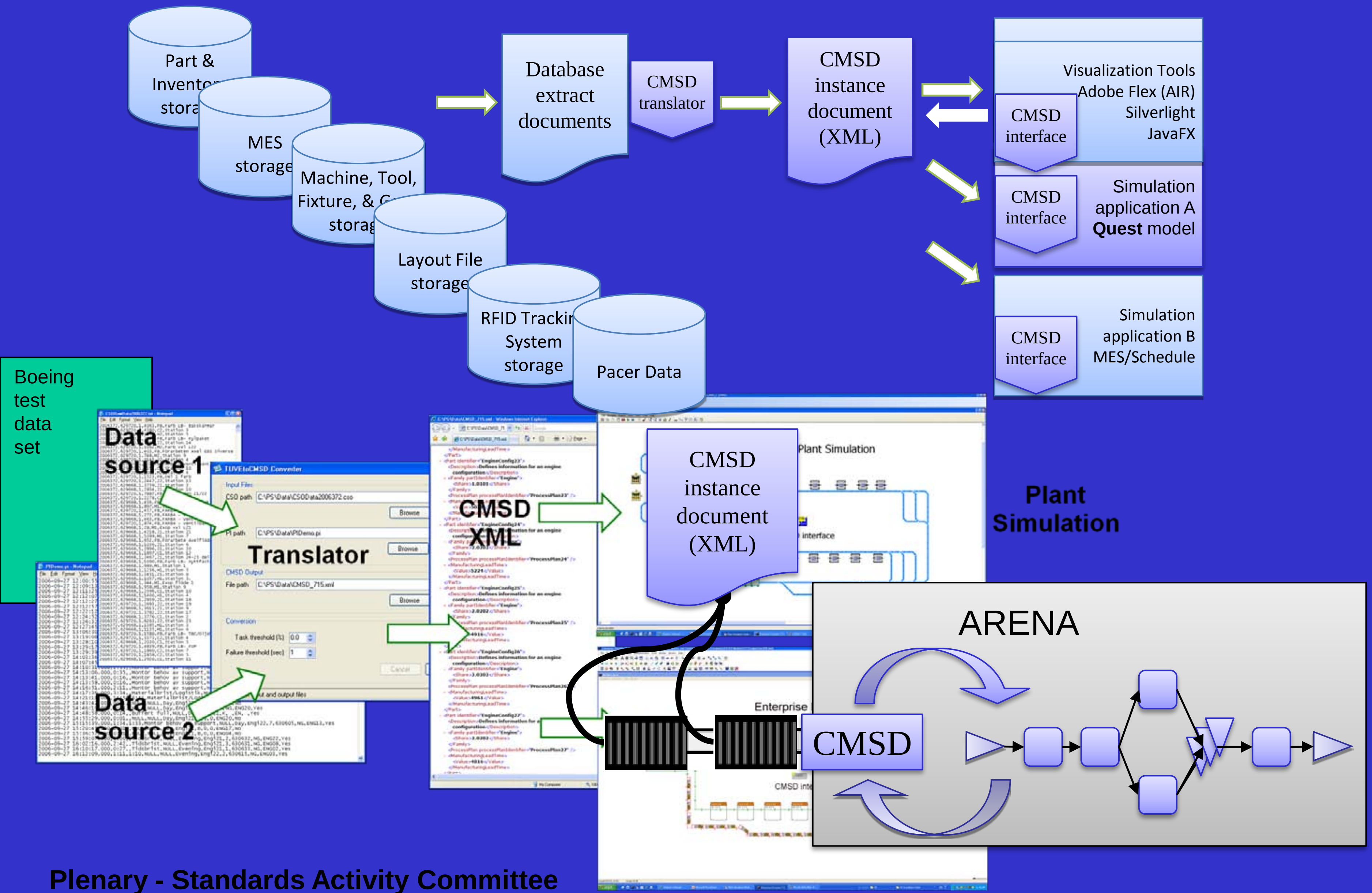
Scope

- The CMSD Information Model describes the entities in the manufacturing domain and the relationship between these entities that are necessary to create manufacturing simulations.
- Manufacturing data includes, but not limited to:
  - Resource information
  - Part and Inventory information
  - Process planning
  - Production operations
- No specification of implementation methods and execution behavior of manufacturing system

Major Data Categories

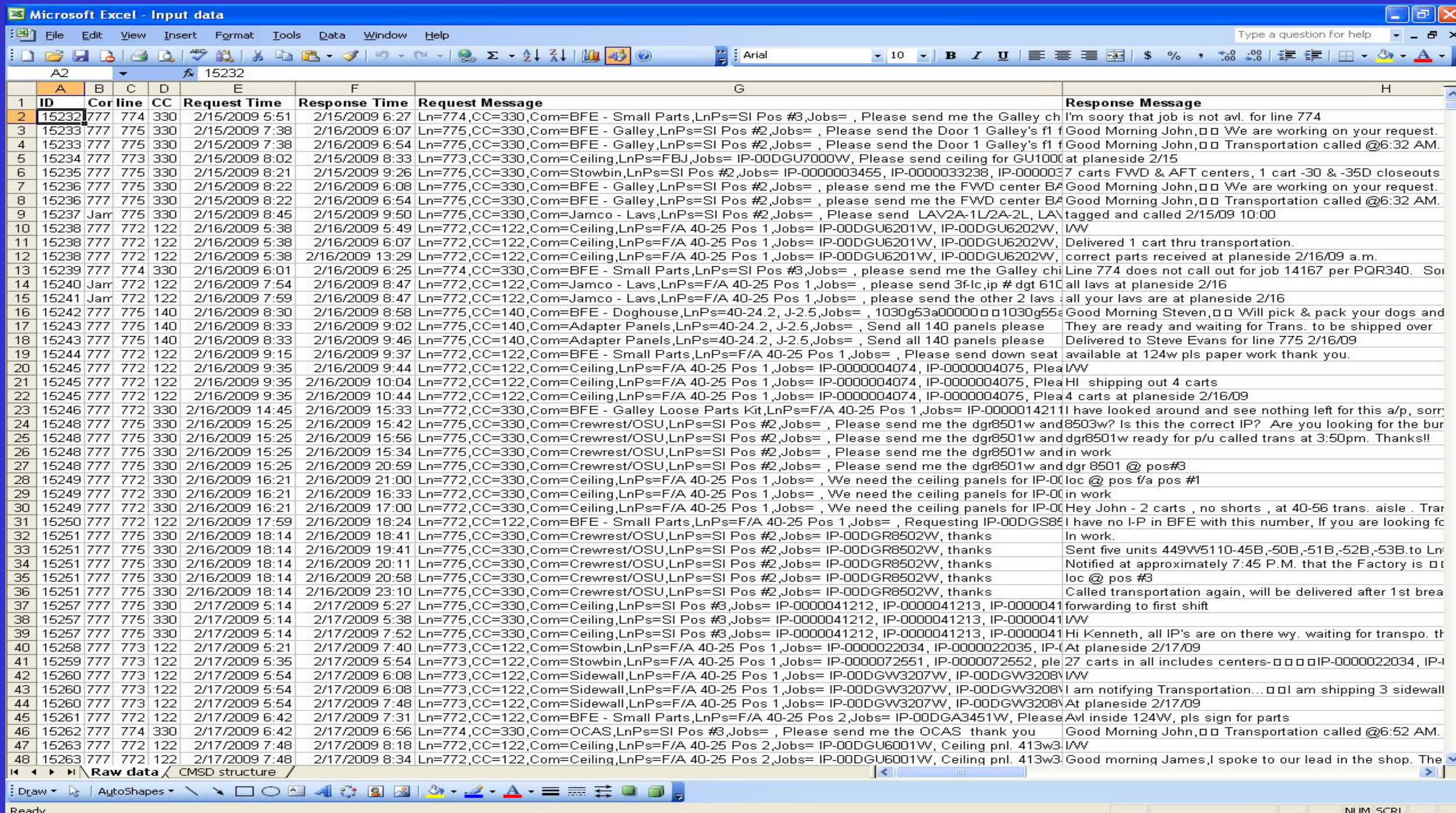
- Organization
- Calendar
- Schedule
- Work
- Process plan
- Operation definition
- Resource
- Skill definition
- Setup definition
- Part
- Bill-of-Materials
- Inventory
- Maintenance plan
- Revision
- Probability distribution
- Reference

A CMSD Pilot Implementation



Plenary - Standards Activity Committee

Pacer Test Data Set



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3	15233	777	775	330	2/15/2009 7:38	2/16/2009 6:07	Ln=775,CC=330,Com=BFE - Galley,LnPs=SI Pos #2,Jobs= , Please send the Door 1 Galley's f1 f	Good Morning John,□□ We are working on your request.
4	15233	777	775	330	2/15/2009 7:38	2/16/2009 6:54	Ln=775,CC=330,Com=BFE - Galley,LnPs=SI Pos #2,Jobs= , Please send the Door 1 Galley's f1 f	Good Morning John,□□ Transportation called @6:32 AM.
5	15234	777	773	330	2/15/2009 8:02	2/15/2009 8:33	Ln=773,CC=330,Com=Ceiling,LnPs=FBJ,Jobs= IP-00DGU7000W, Please send ceiling for GU100(	at planeside 2/15
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7	15236	777	775	330	2/15/2009 8:22	2/16/2009 6:08	Ln=775,CC=330,Com=BFE - Galley,LnPs=SI Pos #2,Jobs= , please send me the FWD center BA	Good Morning John,□□ We are working on your request.
8	15236	777	775	330	2/15/2009 8:22	2/16/2009 6:54	Ln=775,CC=330,Com=BFE - Galley,LnPs=SI Pos #2,Jobs= , please send me the FWD center BA	Good Morning John,□□ Transportation called @6:32 AM.
9	15237	Jam	775	330	2/15/2009 8:45	2/15/2009 9:50	Ln=775,CC=330,Com=Jamco - Lavs,LnPs=SI Pos #2,Jobs= , Please send LAV2A-1L/2A-2L, LA\	tagged and called 2/15/09 10:00
10	15238	777	772	122	2/16/2009 5:38	2/16/2009 5:49	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-00DGU6201W, IP-00DGU6202W,	I/W
11	15238	777	772	122	2/16/2009 5:38	2/16/2009 6:07	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-00DGU6201W, IP-00DGU6202W,	Delivered 1 cart thru transportation.
12	15238	777	772	122	2/16/2009 5:38	2/16/2009 13:29	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-00DGU6201W, IP-00DGU6202W,	correct parts received at planeside 2/16/09 a.m.
13	15239	777	774	330	2/16/2009 6:01	2/16/2009 6:25	Ln=774,CC=330,Com=BFE - Small Parts,LnPs=SI Pos #3,Jobs= , please send me the Galley chi	Line 774 does not call out for job 14167 per PQR340. Soı
14	15240	Jam	772	122	2/16/2009 7:54	2/16/2009 8:47	Ln=772,CC=122,Com=Jamco - Lavs,LnPs=F/A 40-25 Pos 1,Jobs= , please send 3f-lc,ip # dgt 61C	all lavs at planeside 2/16
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16	15242	777	775	140	2/16/2009 8:30	2/16/2009 8:58	Ln=775,CC=140,Com=BFE - Doghouse,LnPs=40-24.2, J-2.5,Jobs= , 1030g53a00000□□1030g55a	Good Morning Steven,□□ Will pick & pack your dogs and
17	15243	777	775	140	2/16/2009 8:33	2/16/2009 9:02	Ln=775,CC=140,Com=Adapter Panels,LnPs=40-24.2, J-2.5,Jobs= , Send all 140 panels please	They are ready and waiting for Trans. to be shipped over
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20	15245	777	772	122	2/16/2009 9:35	2/16/2009 9:44	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000004074, IP-0000004075, Plea	I/W
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22	15245	777	772	122	2/16/2009 9:35	2/16/2009 10:44	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000004074, IP-0000004075, Plea	4 carts at planeside 2/16/09
23	15246	777	772	330	2/16/2009 14:45	2/16/2009 15:33	Ln=772,CC=330,Com=BFE - Galley Loose Parts Kit,LnPs=F/A 40-25 Pos 1,Jobs= IP-00000142111	I have looked around and see nothing left for this a/p, sorr
24	15248	777	775	330	2/16/2009 15:25	2/16/2009 15:42	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= , Please send me the dgr8501w and	8503w? Is this the correct IP? Are you looking for the bur
25	15248	777	775	330	2/16/2009 15:25	2/16/2009 15:56	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= , Please send me the dgr8501w and	dgr8501w ready for p/u called trans at 3:50pm. Thanks!!
26	15248	777	775	330	2/16/2009 15:25	2/16/2009 15:34	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= , Please send me the dgr8501w and	in work
27	15248	777	775	330	2/16/2009 15:25	2/16/2009 20:59	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= , Please send me the dgr8501w and	dgr 8501 @ pos#3
28	15249	777	772	330	2/16/2009 16:21	2/16/2009 21:00	Ln=772,CC=330,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= , We need the ceiling panels for IP-0(	loc @ pos f/a pos #1
29	15249	777	772	330	2/16/2009 16:21	2/16/2009 16:33	Ln=772,CC=330,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= , We need the ceiling panels for IP-0(	in work
30	15249	777	772	330	2/16/2009 16:21	2/16/2009 17:00	Ln=772,CC=330,Com=Ceiling,LnPs=F/A 40-25 Pos 1,Jobs= , We need the ceiling panels for IP-0(	Hey John - 2 carts , no shorts , at 40-56 trans. aisle . Trar
31	15250	777	772	122	2/16/2009 17:59	2/16/2009 18:24	Ln=772,CC=122,Com=BFE - Small Parts,LnPs=F/A 40-25 Pos 1,Jobs= , Requesting IP-00DGS85	I have no I-P in BFE with this number, If you are looking fc
32	15251	777	775	330	2/16/2009 18:14	2/16/2009 18:41	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-00DGR8502W, thanks	In work.
33	15251	777	775	330	2/16/2009 18:14	2/16/2009 19:41	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-00DGR8502W, thanks	Sent five units 449W5110-45B,-50B,-51B,-52B,-53B.to Ln
34	15251	777	775	330	2/16/2009 18:14	2/16/2009 20:11	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-00DGR8502W, thanks	Notified at approximately 7:45 P.M. that the Factory is □□
35	15251	777	775	330	2/16/2009 18:14	2/16/2009 20:58	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-00DGR8502W, thanks	loc @ pos #3
36	15251	777	775	330	2/16/2009 18:14	2/16/2009 23:10	Ln=775,CC=330,Com=Crewrest/OSU,LnPs=SI Pos #2,Jobs= IP-00DGR8502W, thanks	Called transportation again, will be delivered after 1st brea
37	15257	777	775	330	2/17/2009 5:14	2/17/2009 5:27	Ln=775,CC=330,Com=Ceiling,LnPs=SI Pos #3,Jobs= IP-0000041212, IP-0000041213, IP-0000041	forwarding to first shift
38	15257	777	775	330	2/17/2009 5:14	2/17/2009 5:38	Ln=775,CC=330,Com=Ceiling,LnPs=SI Pos #3,Jobs= IP-0000041212, IP-0000041213, IP-0000041	I/W
39	15257	777	775	330	2/17/2009 5:14	2/17/2009 7:52	Ln=775,CC=330,Com=Ceiling,LnPs=SI Pos #3,Jobs= IP-0000041212, IP-0000041213, IP-0000041	Hi Kenneth, all IP's are on there wy. waiting for transpo. th
40	15258	777	773	122	2/17/2009 5:21	2/17/2009 7:40	Ln=773,CC=122,Com=Stowbin,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000022034, IP-0000022035, IP-(	At planeside 2/17/09
41	15259	777	773	122	2/17/2009 5:35	2/17/2009 5:54	Ln=773,CC=122,Com=Stowbin,LnPs=F/A 40-25 Pos 1,Jobs= IP-0000072551, IP-0000072552, ple	27 carts in all includes centers-□□□□IP-0000022034, IP-(
42	15260	777	773	122	2/17/2009 5:54	2/17/2009 6:08	Ln=773,CC=122,Com=Sidewall,LnPs=F/A 40-25 Pos 1,Jobs= IP-00DGW3207W, IP-00DGW3208\	I/W
43	15260	777	773	122	2/17/2009 5:54	2/17/2009 6:08	Ln=773,CC=122,Com=Sidewall,LnPs=F/A 40-25 Pos 1,Jobs= IP-00DGW3207W, IP-00DGW3208\	I am notifying Transportation…□□I am shipping 3 sidewall
44	15260	777	773	122	2/17/2009 5:54	2/17/2009 7:48	Ln=773,CC=122,Com=Sidewall,LnPs=F/A 40-25 Pos 1,Jobs= IP-00DGW3207W, IP-00DGW3208\	At planeside 2/17/09
45	15261	777	772	122	2/17/2009 6:42	2/17/2009 7:31	Ln=772,CC=122,Com=BFE - Small Parts,LnPs=F/A 40-25 Pos 2,Jobs= IP-00DGA3451W, Please	Avl inside 124W, pls sign for parts
46	15262	777	774	330	2/17/2009 6:42	2/17/2009 6:56	Ln=774,CC=330,Com=OCAS,LnPs=SI Pos #3,Jobs= , Please send me the OCAS thank you	Good Morning John,□□ Transportation called @6:52 AM.
47	15263	777	772	122	2/17/2009 7:48	2/17/2009 8:18	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 2,Jobs= IP-00DGU6001W, Ceiling pnl. 413w3	I/W
48	15263	777	772	122	2/17/2009 7:48	2/17/2009 8:34	Ln=772,CC=122,Com=Ceiling,LnPs=F/A 40-25 Pos 2,Jobs= IP-00DGU6001W, Ceiling pnl. 413w3	Good morning James,I spoke to our lead in the shop. The

• The Pacer data will be mapped into the Core Manufacturing Simulation Data (CMSD) structure

Sorted Pacer Data

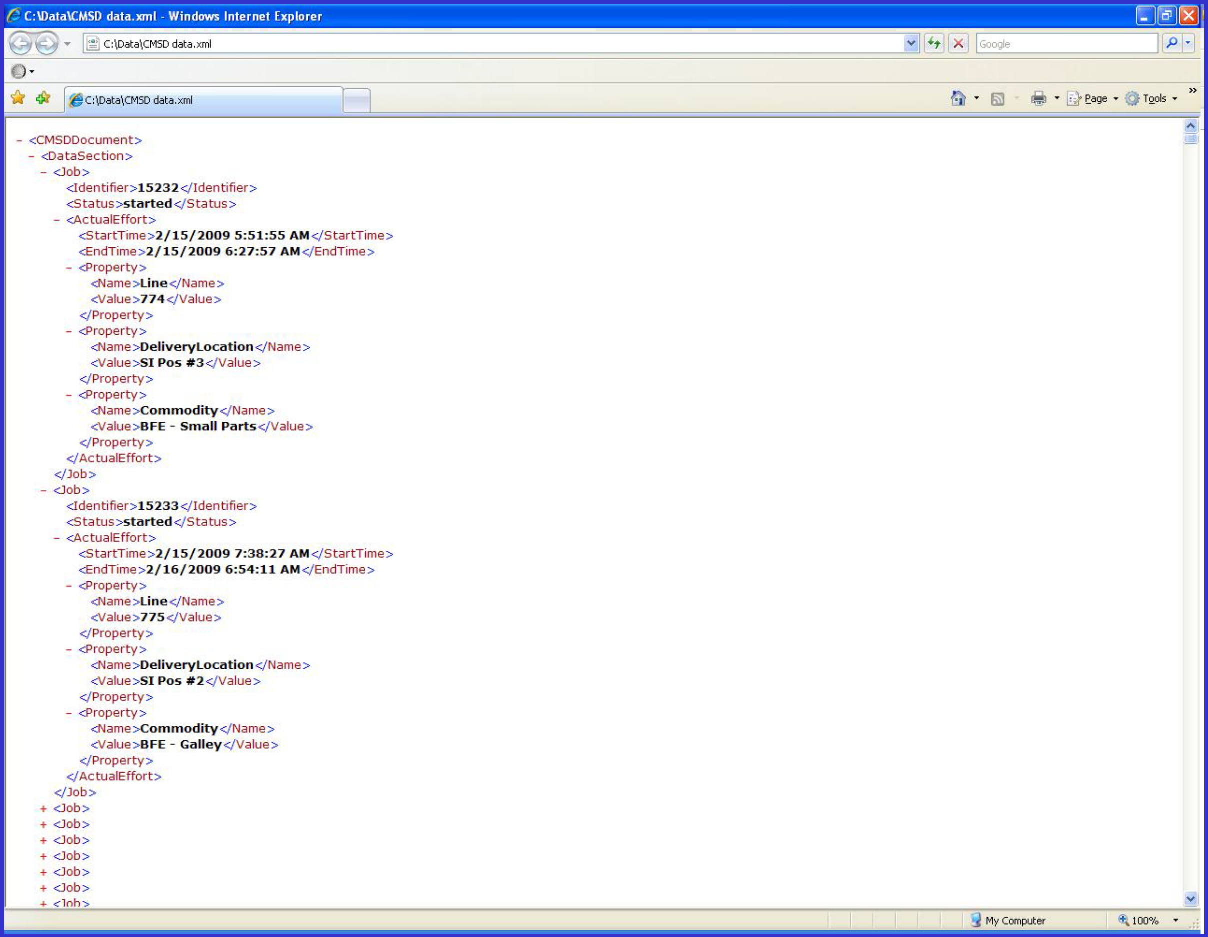
Microsoft Excel - Input data

ID	line	Request Time	Response Time	Delivery Location	Commodity
15232	774	2/15/2009 5:51	2/15/2009 6:27	SI Pos #3	BFE - Small Parts
15233	775	2/15/2009 7:38	2/16/2009 6:54	SI Pos #2	BFE - Galley
15234	773	2/15/2009 8:02	2/15/2009 8:33	FBJ	Ceiling
15235	775	2/15/2009 8:21	2/15/2009 9:26	SI Pos #2	Stowbin
15236	775	2/15/2009 8:22	2/16/2009 6:54	SI Pos #2	BFE - Galley
15237	775	2/15/2009 8:45	2/15/2009 9:50	SI Pos #2	Jamco - Lavs
15238	772	2/16/2009 5:38	2/16/2009 13:29	F/A 40-25 Pos 1	Ceiling
15239	774	2/16/2009 6:01	2/16/2009 6:25	SI Pos #3	BFE - Small Parts
15240	772	2/16/2009 7:54	2/16/2009 8:47	F/A 40-25 Pos 1	Jamco - Lavs
15241	772	2/16/2009 7:59	2/16/2009 8:47	F/A 40-25 Pos 1	Jamco - Lavs
15242	775	2/16/2009 8:30	2/16/2009 8:58	40-24.2, J-2.5	BFE - Doghouse
15243	775	2/16/2009 8:33	2/16/2009 9:46	40-24.2, J-2.5	Adapter Panels
15244	772	2/16/2009 9:15	2/16/2009 9:37	F/A 40-25 Pos 1	BFE - Small Parts
15245	772	2/16/2009 9:35	2/16/2009 10:44	F/A 40-25 Pos 1	Ceiling
15246	772	2/16/2009 14:45	2/16/2009 15:33	F/A 40-25 Pos 1	BFE - Galley Loose Parts Kit
15248	775	2/16/2009 15:25	2/16/2009 20:59	SI Pos #2	Crewrest/OSU
15249	772	2/16/2009 16:21	2/16/2009 17:00	F/A 40-25 Pos 1	Ceiling
15250	772	2/16/2009 17:59	2/16/2009 18:24	F/A 40-25 Pos 1	BFE - Small Parts
15251	775	2/16/2009 18:14	2/16/2009 23:10	SI Pos #2	Crewrest/OSU
15257	775	2/17/2009 5:14	2/17/2009 7:52	SI Pos #3	Ceiling
15258	773	2/17/2009 5:21	2/17/2009 7:40	F/A 40-25 Pos 1	Stowbin
15259	773	2/17/2009 5:35	2/17/2009 5:54	F/A 40-25 Pos 1	Stowbin
15260	773	2/17/2009 5:54	2/17/2009 7:48	F/A 40-25 Pos 1	Sidewall
15261	772	2/17/2009 6:42	2/17/2009 7:31	F/A 40-25 Pos 2	BFE - Small Parts
15262	774	2/17/2009 6:42	2/17/2009 6:56	SI Pos #3	OCAS
15263	772	2/17/2009 7:48	2/17/2009 14:05	F/A 40-25 Pos 2	Ceiling
15264	773	2/17/2009 8:43	2/17/2009 8:58	F/A 40-25 Pos 1	Ceiling
15265	772	2/17/2009 9:23	2/17/2009 11:16	F/A 40-25 Pos 2	Carpets
15266	773	2/17/2009 9:35	2/17/2009 9:44	F/A 40-25 Pos 1	Door Liner
15267	773	2/17/2009 9:41	2/17/2009 11:12	F/A 40-25 Pos 1	Sidewall
15268	773	2/17/2009 10:43	2/18/2009 5:51	F/A 40-25 Pos 1	BFE - Galley
15269	772	2/17/2009 10:46	2/17/2009 11:26	F/A 40-25 Pos 1	Carpets
15270	775	2/17/2009 13:33	2/17/2009 14:31	SI Pos #3	BFE - Small Parts
15271	775	2/17/2009 13:43	2/18/2009 5:18	SI Pos #3	OCAS
15272	772	2/17/2009 15:05	2/17/2009 15:11	F/A 40-25 Pos 2	Mats
15273	774	2/17/2009 15:09	2/17/2009 16:04	FBJ	BFE - Small Parts
15274	774	2/17/2009 15:12	2/18/2009 7:02	FBJ	Ceiling
15275	772	2/17/2009 15:15	2/18/2009 5:57	F/A 40-24	Adapter Panels
15276	772	2/17/2009 15:17	2/17/2009 16:35	F/A 40-24	BFE - Small Parts
15277	773	2/17/2009 15:38	2/17/2009 16:36	F/A 40-25 Pos 1	BFE - Small Parts
15278	772	2/17/2009 15:45	2/17/2009 16:36	F/A 40-25 Pos 1	BFE - Small Parts
15279	772	2/17/2009 16:21	2/17/2009 17:36	F/A 40-25 Pos 2	Mats
15281	772	2/17/2009 17:18	2/17/2009 18:14	F/A 40-25 Pos 2	IRC - All
15282	772	2/17/2009 19:11	2/17/2009 20:56	F/A 40-25 Pos 2	Partition
15283	775	2/17/2009 19:27	2/17/2009 20:18	SI Pos #3	BFE - Small Parts
15284	775	2/17/2009 21:30	2/17/2009 22:11	SI Pos #3	Carpets
15285	775	2/18/2009 1:56	2/18/2009 2:43	SI Pos #1	Carpets

Raw data | CMSD structure

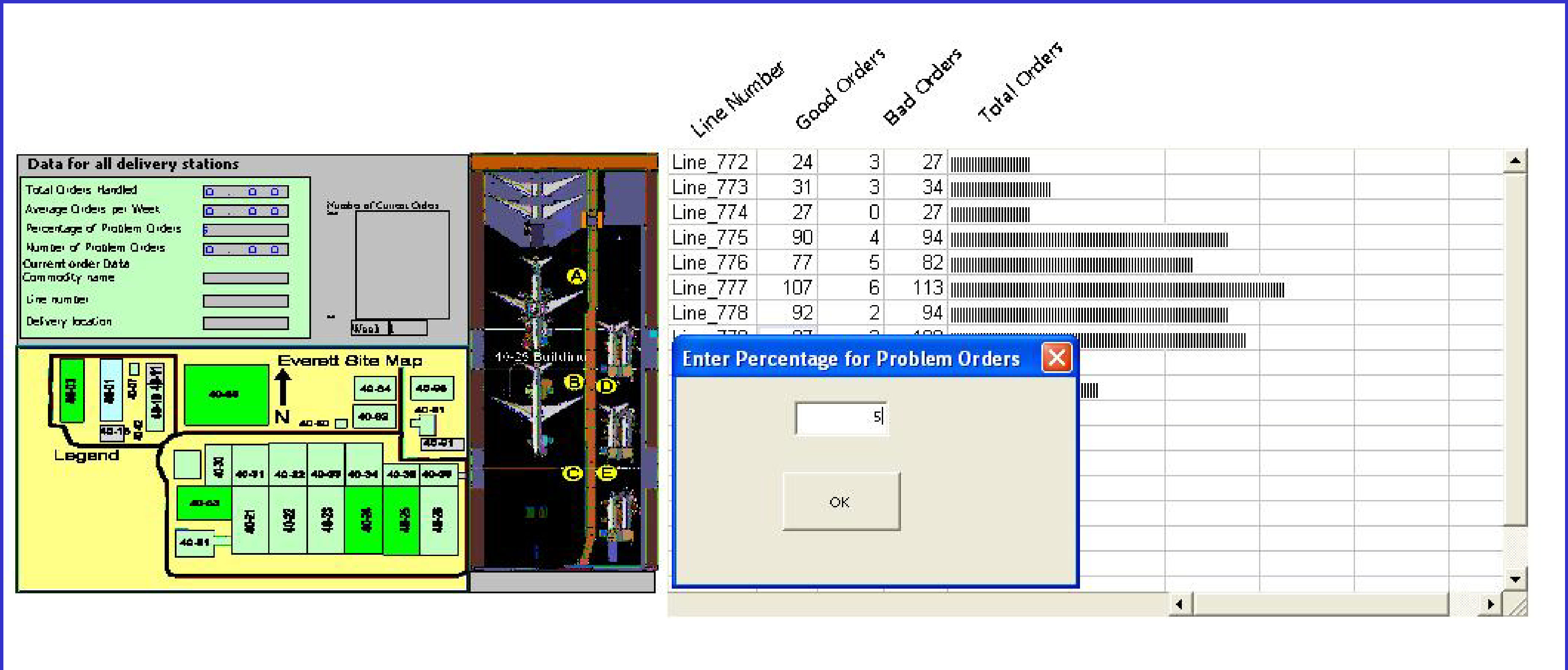
- The Pacer test data has been sorted, edited, and ready to be mapped to the CMSD data structures

Sample CMSD XML



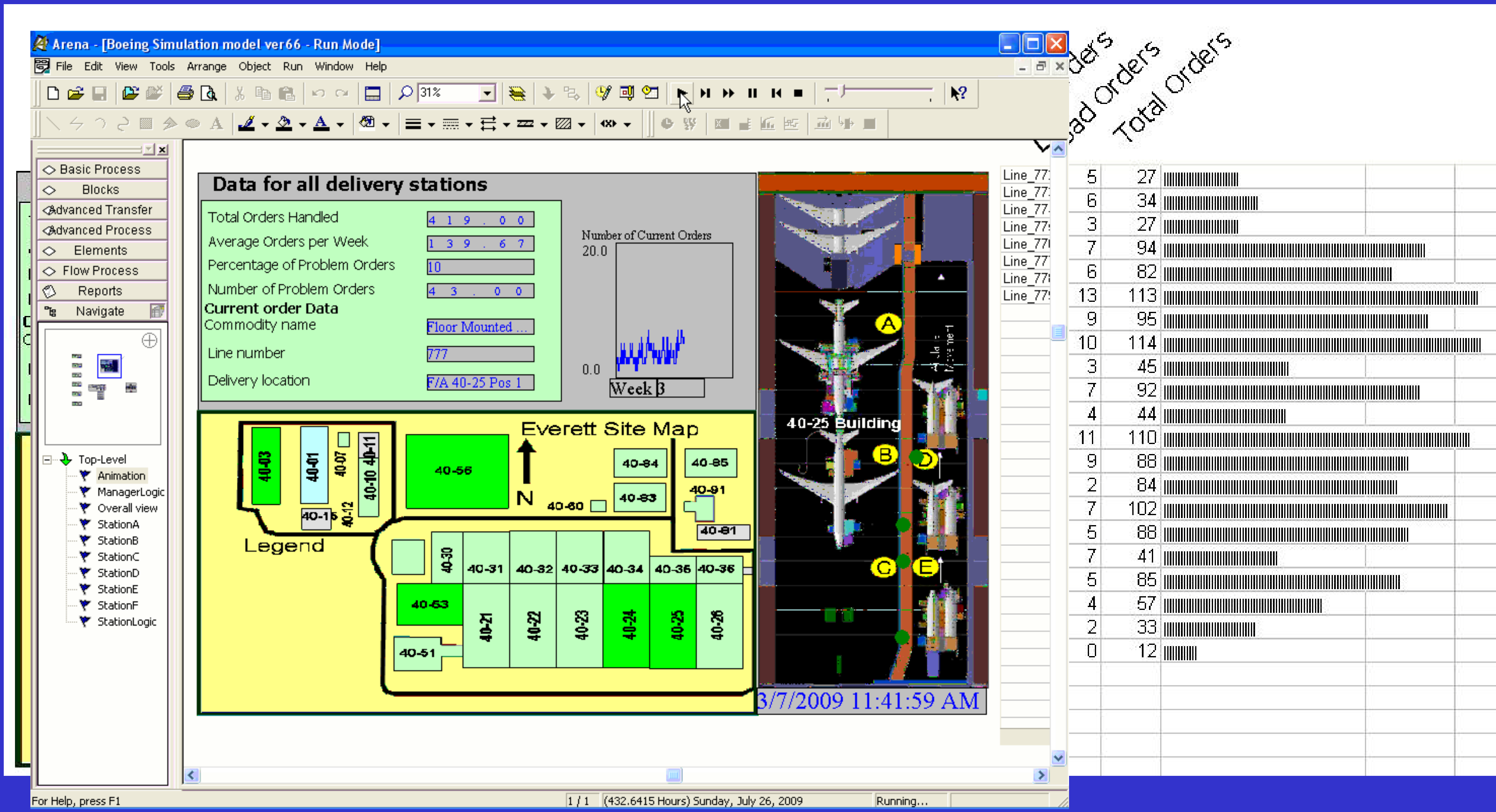
- The first row of the Excel file mapped into the CMSD structure

A Hypothetical Case Simulation



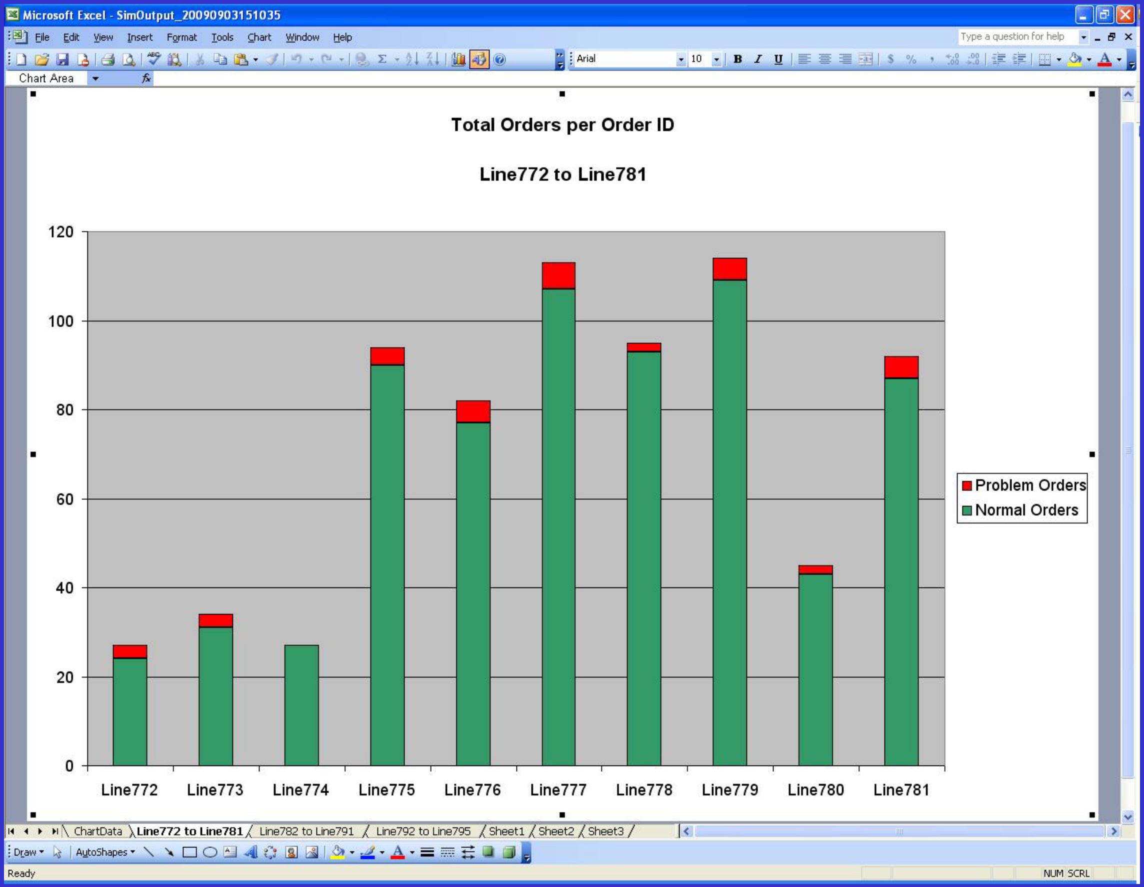
- Develop a front end for manufacturing engineer to perform what-if scenarios and iterations of simulation and analysis

Sample Arena output



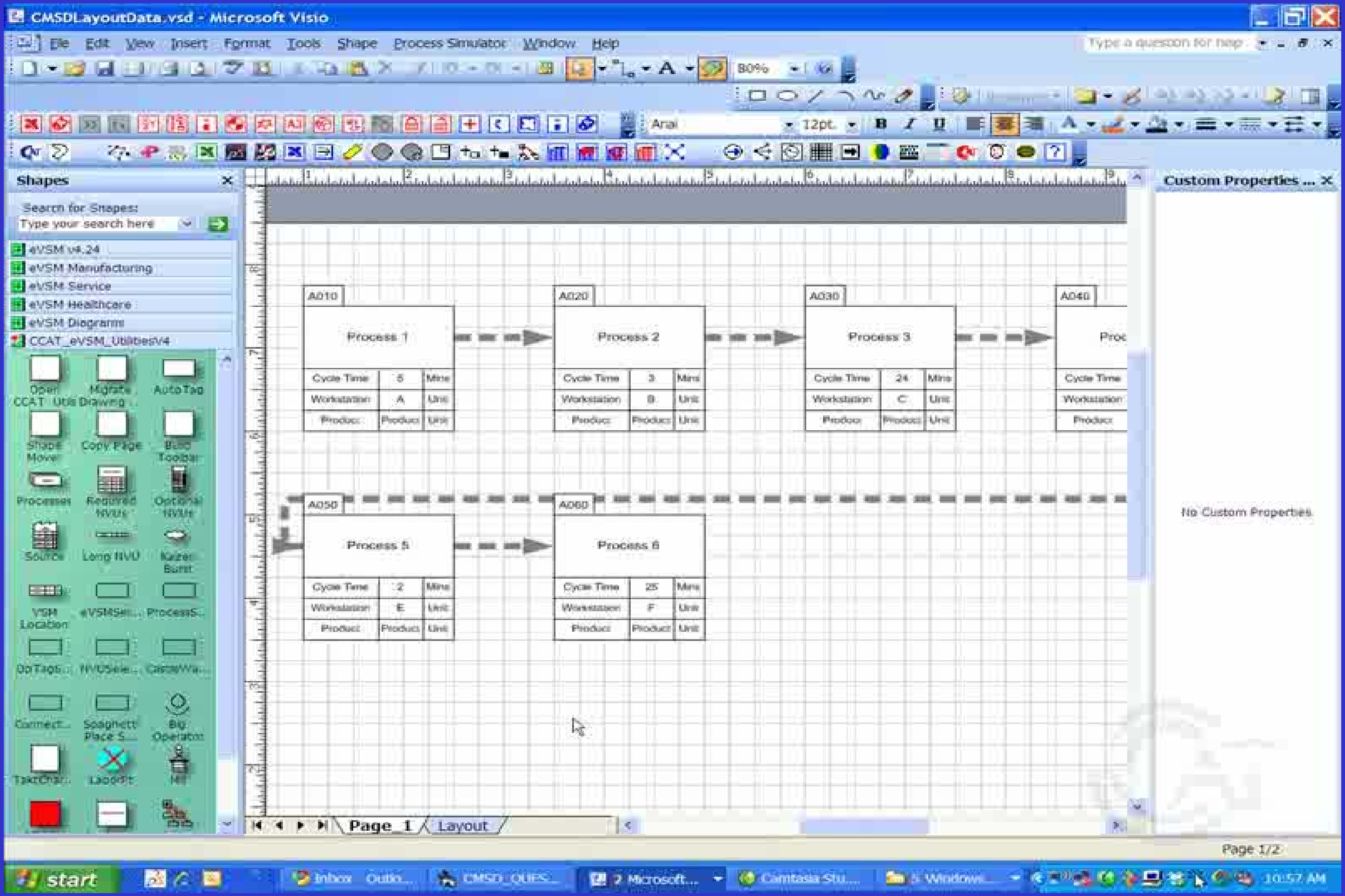
- Arena animation and bar chart for the total number of delivery orders processed.

Sample Arena output



- Total number of orders per line number in Microsoft Excel

Value Stream Mapping to Quest Model



Value Stream Mapping process data to a basic Delmia Quest Model

Industry

- Use visualization and simulation to meet the DoD's Manufacturing Readiness Level (MRL) : Value Stream Map (VSM) process data and simulation to demonstrate manufacturing readiness.
- Engineers spent too much time and effort to prepare and process input data to simulation
- Engineers take too long to create simulation models

Automatically create a basic Delmia Quest Model from Value Stream Mapping (VSM) process data.

Simulation Standards Consortium

Government

- *Modeling & Simulation Coordination Office*
- *NIST (Coordinator)*
- *DoD/Air Force Research Lab*

Software Vendors

- *Brooks Automation - AutoSimulation*
- *Delmia Company*
- *Siemen/UGS Plant Simulation*
- *Enterprise Dynamics*
- *Geer Mountain Software*
- *ProModel Corporation*
- *Rockwell Software – Arena*
- *Flexsim*
- *Simul8*
- *Visual Component*
- *Virtools*
- *Witness*
- *Wolverine Software*

Industry

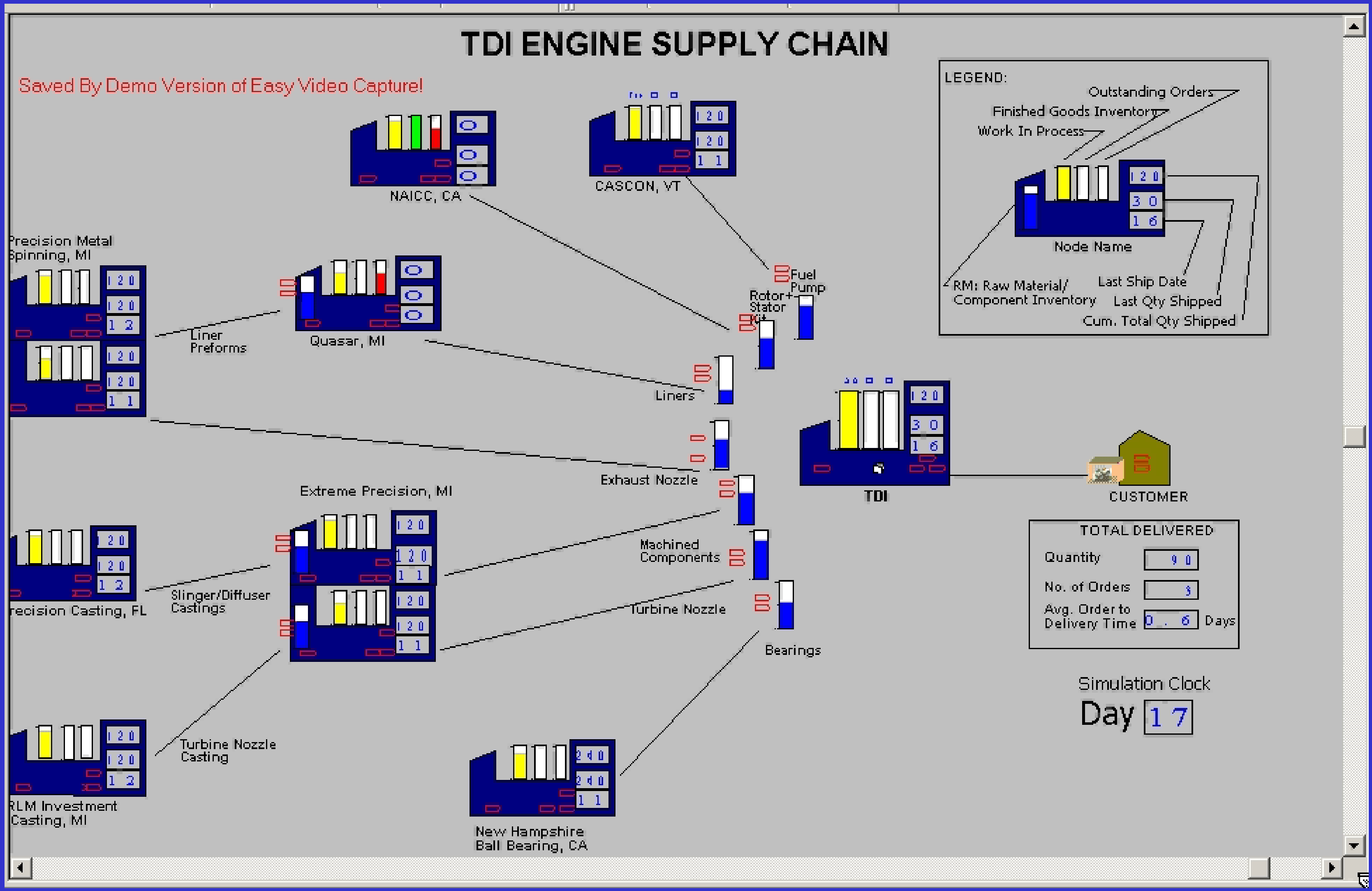
- *The Boeing Company*
- *Volvo Car Company*
- *Lockheed Martin*
- *Raytheon*
- *Rockwell Collins*
- *Connecticut Center for Advanced Technology*
- *CostVision*
- *DSN Innovations*
- *Ford Motor Company*
- *General Motors*
- *John Deere*

Academia

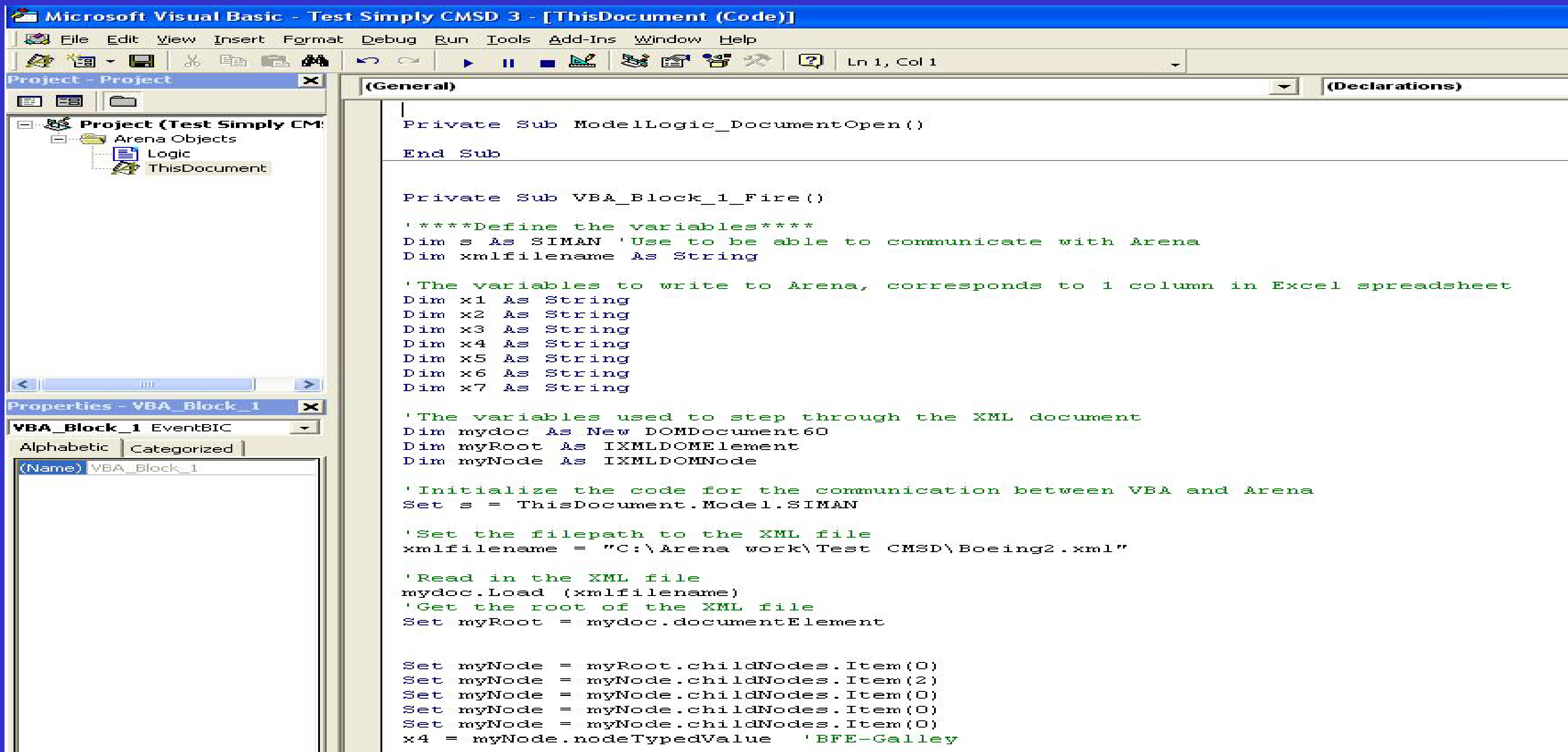
- *Chalmers University*
- *George Washington University*
- *University of Arizona*
- *Georgia Tech*
- *Florida International University*
- *Carnegie Mellon University*

Q&A

Supply Chain Simulation

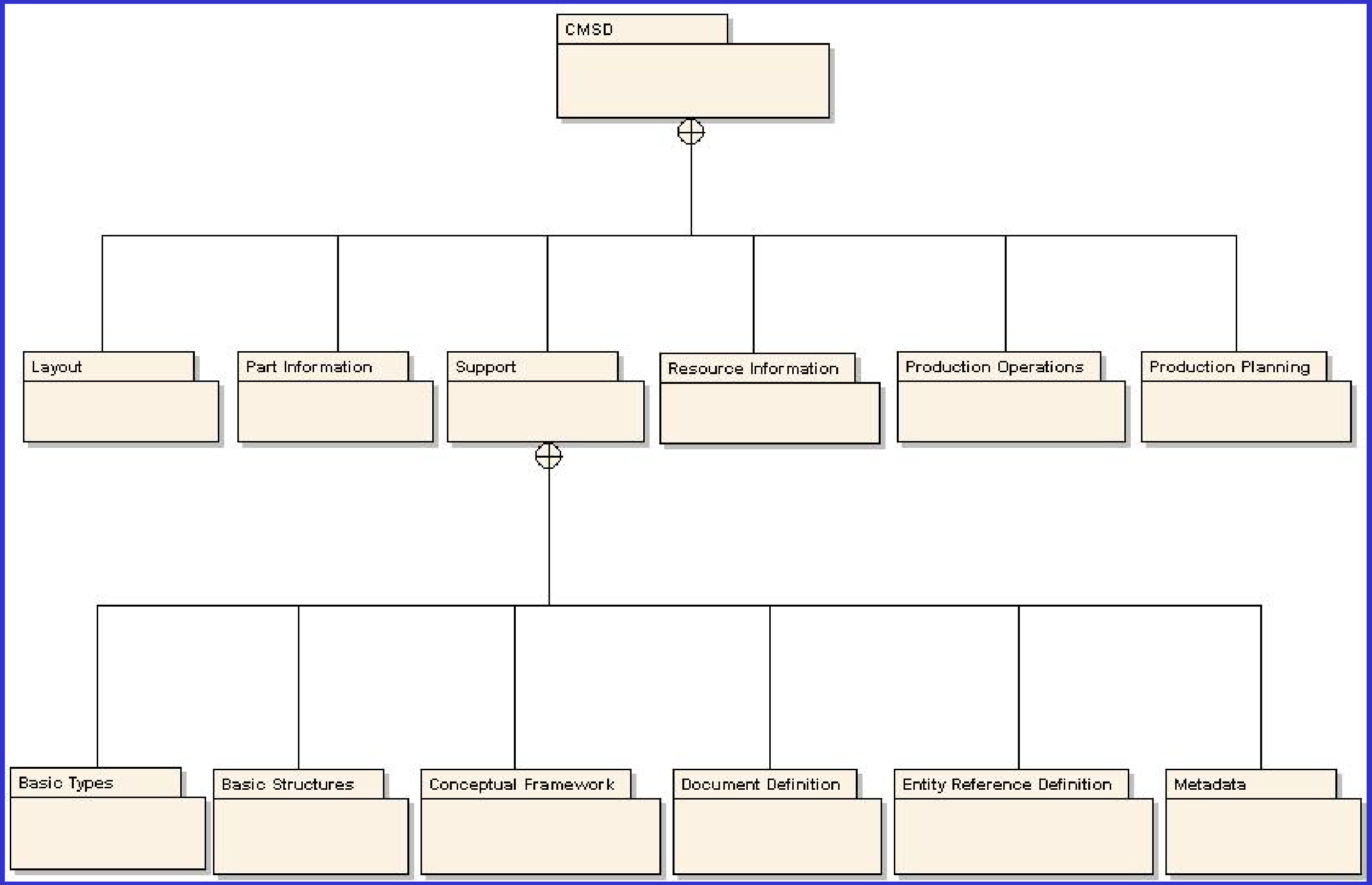


Sample CMSD interface to Arena

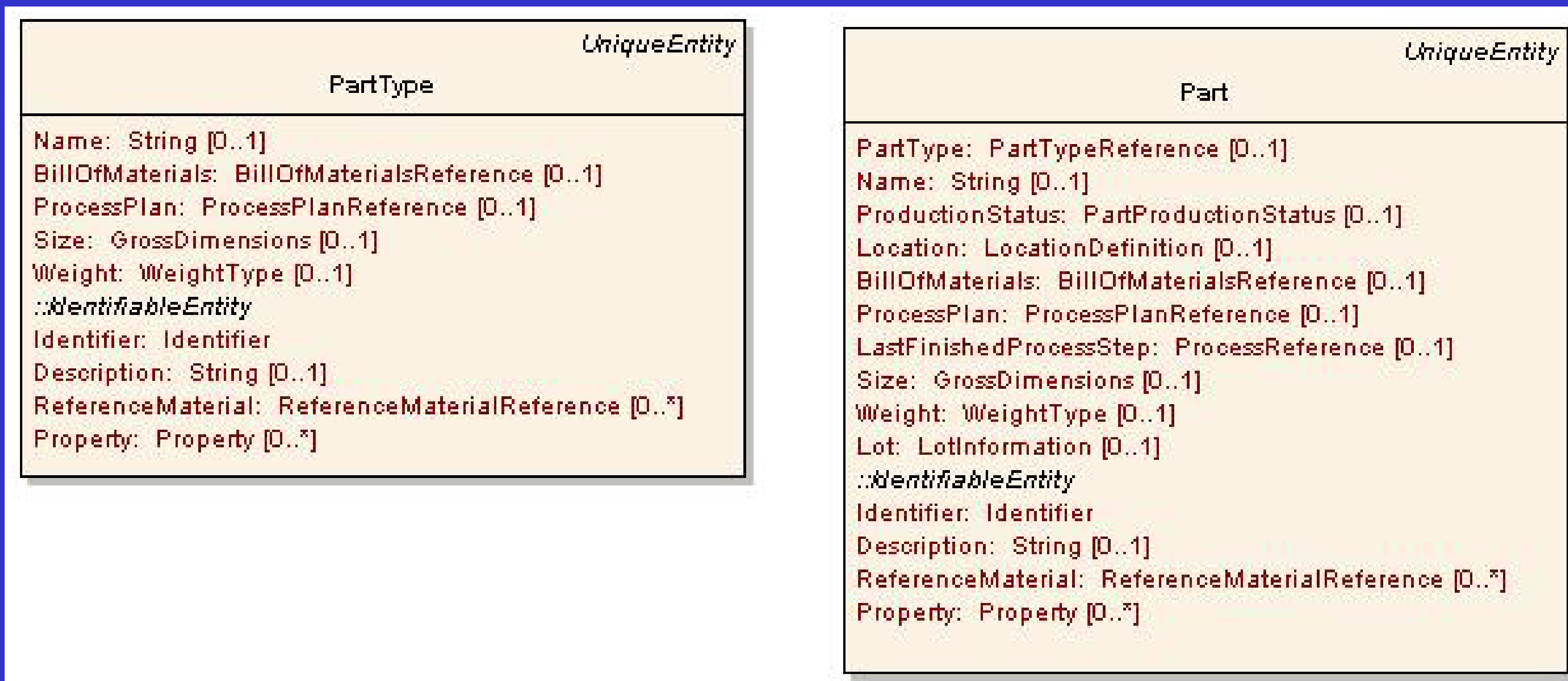


- Sample VBA script in Arena
- Using the XML DOM standard to read in the CMSD XML file
- Use Arena SIMAN code to set the variables in Arena model

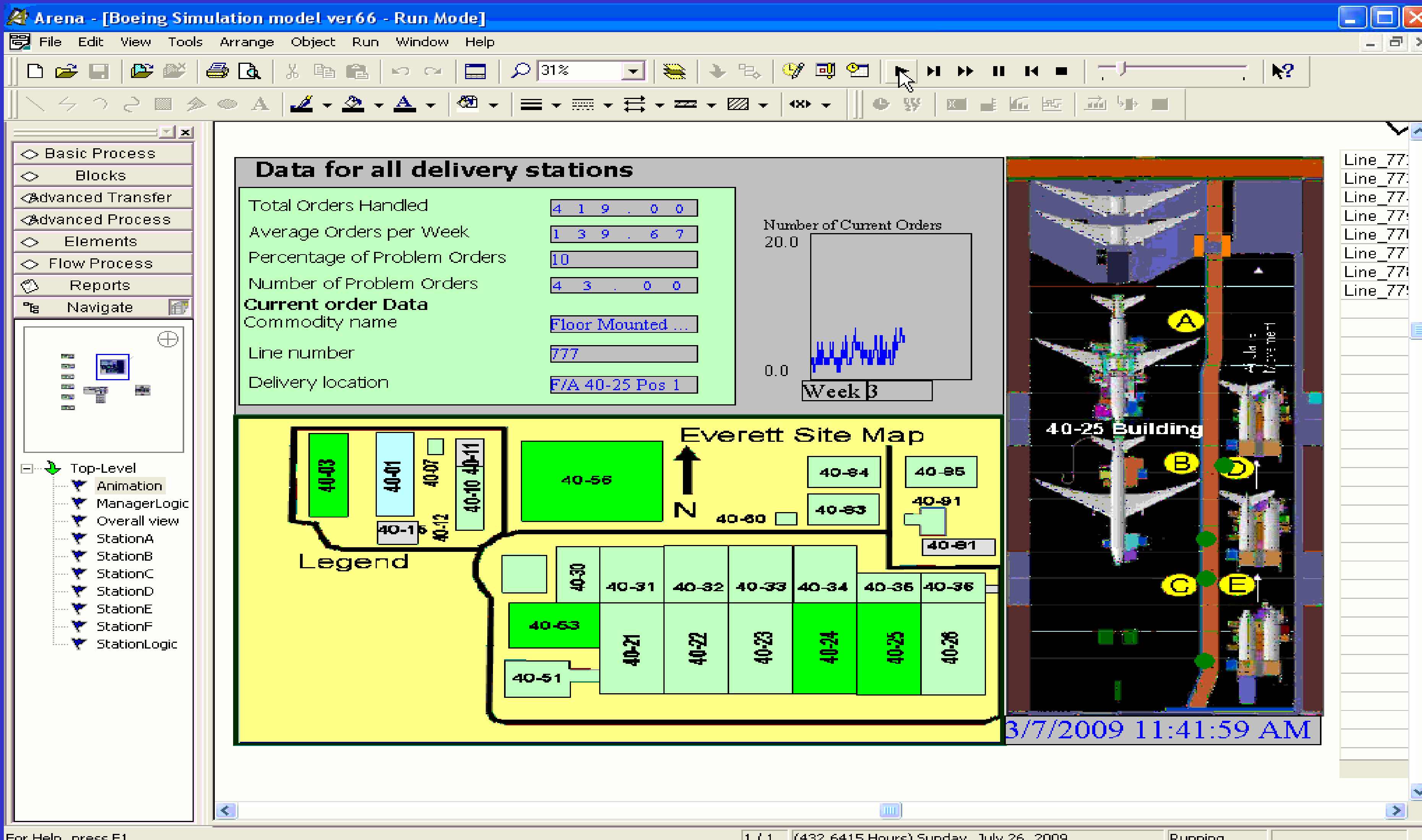
Sample CMSD UML Diagram



Sample CMSD UML Diagram



Sample Arena output



- Arena animation and bar chart for the total number of delivery orders processed.

9097 - Acquisition ESOH Risk Management - How to Make It Work

NDIA Systems Engineering Conference
Track 1 – Systems Engineering Effectiveness
San Diego, CA

Robert E. Smith, CSP
Booz Allen Hamilton

Sherman G. Forbes
Office of the Deputy Assistant Secretary of the Air Force for Acquisition (SAF/AQ)

October 29, 2009

Contents

Purpose

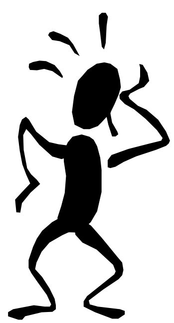
- To describe how the DoD Acquisition Environment, Safety, and Occupational Health (ESOH) Risk Management (RM) process can work most effectively as part of the Systems Engineering process
- To highlight common elements of unsuccessful and successful ESOH RM processes

Background

- Many DoD Acquisition Program Offices have tried and not been very successful at implementing effective and efficient ESOH RM efforts, while some Program Offices have implemented programs have been successful
- Based on lessons learned from multiple program office experiences, there are some common elements of unsuccessful and successful ESOH RM efforts

How do you feel about your ESOH RM efforts?

Unsuccessful ESOH RM efforts



vs.

Successful ESOH RM efforts

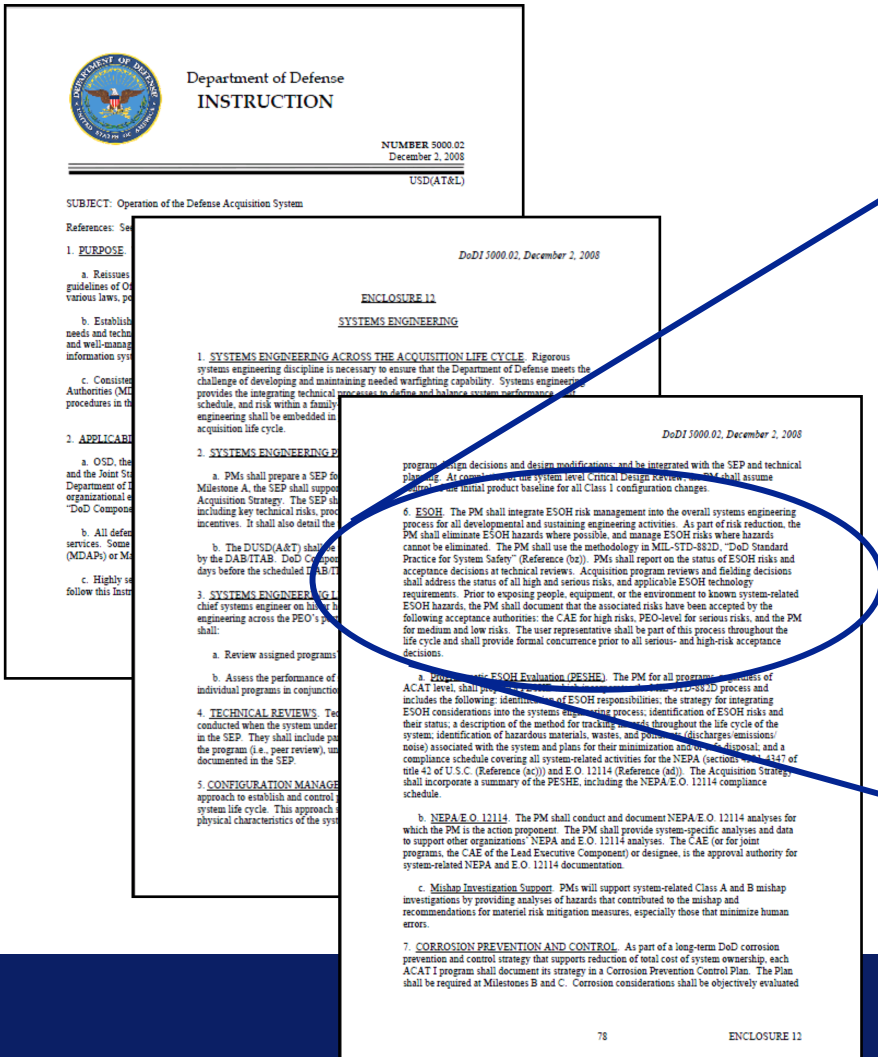
USD(AT&L) Policy Memorandums Related to ESOH

- Defense Acquisition System Safety, September 23, 2004
  - Use Standard Practice for System Safety, MIL-STD-882D to manage ESOH risk
  - Report ESOH risk status and acceptance decisions at technical and program reviews
- Reducing Preventable Accidents, November 21, 2006
  - Address status of each High and Serious ESOH risk and compliance with applicable safety technology requirements at all program reviews
- Defense Acquisition System Safety – ESOH Risk Acceptance, March 7, 2007
  - Formal acceptance of ESOH risks prior to exposing people, equipment, or the environment to a known system-related ESOH hazard
  - User Representative Formal Concurrence for High and Serious ESOH risks

These basic requirements have been in place for several years & incorporated into the new DoDI 5000.02

Requirements

- December 8, 2008 DoD Instruction (DoDI) 5000.02 defines the basic requirements for Acquisition Program Office ESOH RM to be part of the overall Systems Engineering process

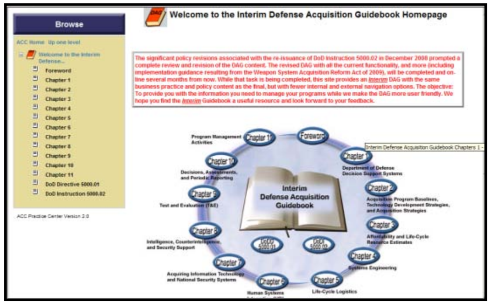


The PM shall integrate ESOH risk management into the overall systems engineering process for all developmental and sustaining engineering activities. As part of risk reduction, the PM shall eliminate ESOH hazards where possible, and manage ESOH risks where hazards cannot be eliminated. The PM shall use the methodology in MIL-STD-882D, "DoD Standard Practice for System Safety".

DoDI 5000.02, Enclosure 12

Guidance for ESOH / SE Integration

- DoD Defense Acquisition Guidebook (DAG)
  - Provides detailed guidance on how DoD expects Acquisition Program Offices to meet the ESOH RM requirements defined in DoDI 5000.02
  - **https://acc.dau.mil/dag**



- ESOH In Acquisition – Integrating ESOH into Systems Engineering
  - Depicts when ESOH activities should be performed to influence system design throughout SE process
  - Includes the ESOH Management Evaluation Criteria published by DDR&E and DUSD(I&E)

- Acquisition Community Connection (ACC)
  - Provides best practices on how to integrate ESOH considerations into the systems engineering and acquisition processes
  - **https://acc.dau.mil/esoh**

Common Elements of Unsuccessful ESOH RM Efforts

- Disconnect between ESOH Analysis and Design Activities
  - Difficult to implement ESOH recommendations for completed SE work products
  - ESOH recommendations will meet resistance and typically have limited success
  - Failure to follow through on recommendations and to work to viable mitigation solutions with Design Activities and the User Community
  - Failure of E, S, and OH Subject Matter Experts to work closely together with SE
    - » E, S, and OH provide conflicting program recommendations on same issues
    - » SSWG focused only on Safety; EWG focused only on Pollution Prevention
  - Failure to have E & OH Representatives as part of the ESOH effort
  - Trying to communicate a major design change to reduce ESOH risk at the wrong time could cost the program significant schedule and budget – obviously this will not be well-received

Common Elements of Unsuccessful ESOH RM Efforts (cont)

- ESOH Personnel are viewed by Management and Engineering as road blocks, not team members
- While the amount of resources applied to the ESOH RM efforts will have an impact on the quality of the outcomes, it is not the most critical factor
- Many large Acquisition Programs have allocated significant resources (funding and personnel) for ESOH RM
  - Can produce reduction of ESOH risks on the system despite organizational impediments
  - For example, large programs have been doing a good job at Hazardous Materials Management
  - However, utilizing substantial program funding for ESOH RM is not a sustainable approach

Common Elements of Successful ESOH RM Efforts

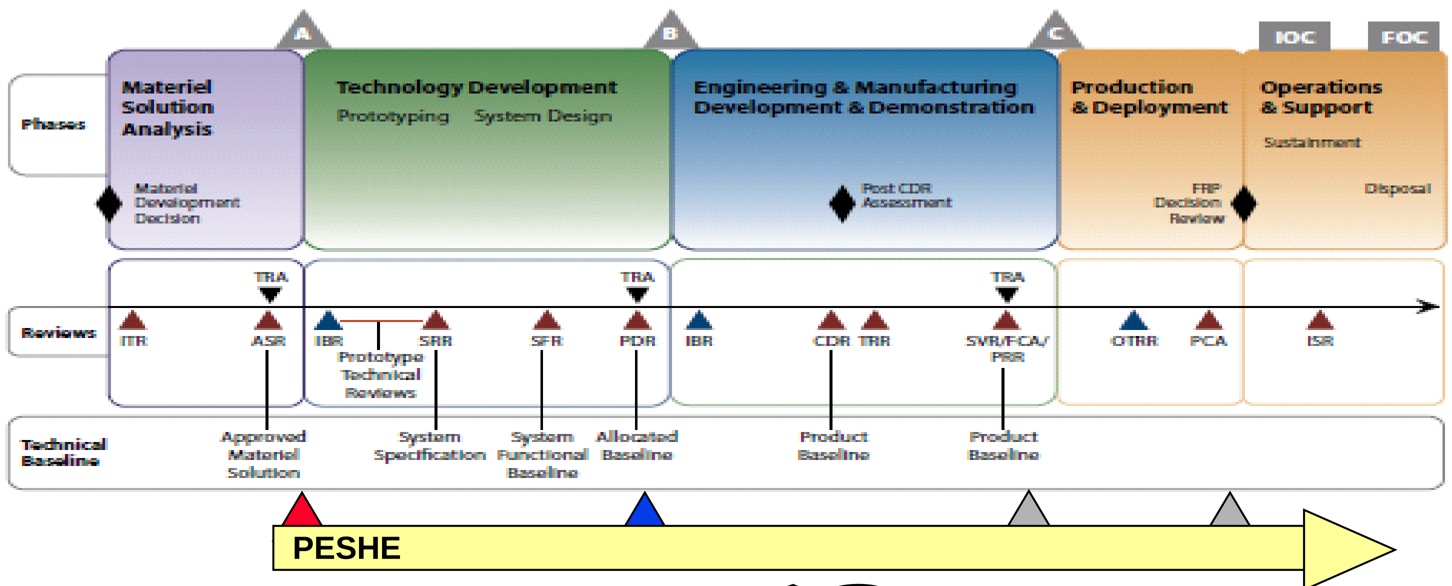
- An ESOH RM effort has to be part of and be able to influence the day-to-day decision making that occurs in the Systems Engineering process
  - Provide informative and timely ESOH inputs to Systems Engineering
    - » Direct line of communication to Systems Engineering, including Product/Engineering Integrated Product Team (IPTs)
    - » Daily ESOH communication via IPT meetings, phonecons, test logs
    - » Direct line of communication to test sites and/or end-users
  - E, S, and OH Subject Matter Experts work together to optimize recommendations across these functional areas
  - Implement closed-loop ESOH hazard tracking system, to include status of recommended mitigation measures
  - Integrate ESOH within Configuration Management Processes
    - » ECR/ECP reviews, technical document reviews, etc.
    - » Require ESOH review and approval for changes to be finalized
  - Participate in program and technical reviews (esp. PDR & CDR) to report risk and applicable ESOH technology status

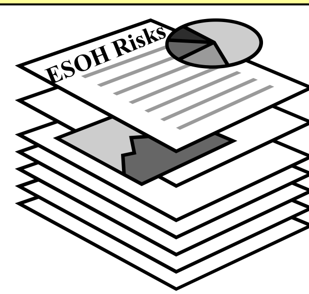
Common Elements of Successful ESOH RM Efforts (cont)

- Program Manager and Chief Engineer are knowledgeable and understanding of ESOH efforts
  - PM and Chief Engineer views ESOH as team members and not as roadblocks
- The knowledge, skills, and abilities of the ESOH practitioners supporting a program can have a significant impact on the success of the Acquisition Program Office's ESOH RM efforts
  - ESOH practitioners need to be knowledgeable in their system, their system’s operating environment, and also knowledgeable in applicable laws and regulations
- ESOH Professionals should have strong, in-depth knowledge of the ESOH risks AND potential mitigations
  - During IPT meetings and before/during design reviews, ESOH participation can provide expert feedback real-time to best influence design to reduce ESOH risk
  - During test site visits or end-user discussions, ESOH participation can receive real-time feedback on suggestions and/or concerns from those that work daily with the system to best influence design to reduce ESOH risk

Common Elements of Successful ESOH RM Efforts (cont)

- Programmatic ESOH Evaluation (PESHE): A living document that guides and documents identification and management of ESOH risks.
  - The ONLY DoD-required ESOH document!
  - Successful PESHEs document what the programs plans to do or is doing, is consistent with where the program is in the life cycle, and **does not** just restate policy





Start
Initial Completion
Update Required

Starts as a planning document

Becomes an ESOH Risk Management Status Report

Conclusion

- If the ESOH team is removed from the Systems Engineering process, having a direct line to the Program Manager and/or having a large ESOH budget may not effectively influence design changes to mitigate ESOH risk
- If the ESOH RM efforts (resources and personnel) are a fully integrated part of the Systems Engineering team and efforts, then the likelihood of having a successful ESOH RM effort will be much higher than a better-resourced ESOH RM effort that is operating outside of the System Engineering process, even if it is reporting directly to the Program Manager
- Knowledgeable and experienced ESOH Professionals can effectively communicate ESOH risks and mitigations on a day-to-day basis within the Systems Engineering process to influence design changes and eliminate or reduce risk

Questions?

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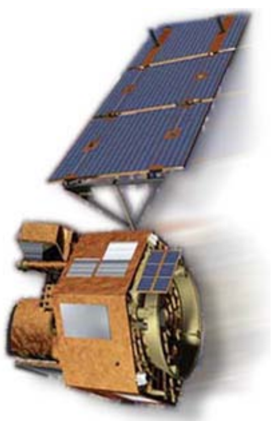
Arlington, VA 22202-4158
703-412-7661
smith_bob@bah.com

Static Code Analysis: Best Practices for Software Assurance in the Acquisition Life Cycle



Paul R. Croll

Fellow

CSC

pcroll@csc.com

Chair, NDIA Software Industry Experts Panel

Industry Co-Chair, NDIA Systems Assurance Committee

Outline

- Setting the Stage for Static Code Analysis
  - What is Static Code Analysis?
  - The Scope of The Problem
  - Testing vs. Static Code Analysis
  - What Code Do You Analyze?
  - A Three-Phase Code Analysis Process
  - The Assurance Case
- Static Code Analysis in the Acquisition Life Cycle
- Challenges to Effective Static Code Analysis
- Useful Links

Setting the Stage for Static Code Analysis

What is Static Code Analysis?

- Static code analysis is the process of evaluating a system or component based on its form, structure, content, or documentation. From a software assurance perspective, static analysis addresses weaknesses in program code that might lead to vulnerabilities
- Such analysis may be manual, as in code inspections, or automated through the use of one or more tools
- Automated static code analyzers typically check source code but there is a smaller set of analyzers that check byte code and binary code, especially useful when source code in not available (e.g for COTS components).

The Scope of The Problem

Size in FP	Civilian Government Projects	Military Projects	*Average*
1	1	1	*1*
10	5	4	*5*
100	29	14	*24*
1,000	155	55	*120*
10,000	832	209	*600*
100,000	4,467	794	*3,031*
1,000,000	23,988	3,020	*15,412*
Average	*4,211*	*585*	*2,742*

Figure 1. Estimated Number of Security Vulnerabilities in Software Applications. Source: Capers Jones © 2008

Size in FP	Civilian Government Projects	Military Projects	*Average*
1	25.00%	5.00%	*11.29%*
10	35.00%	15.00%	*26.00%*
100	45.00%	20.00%	*33.57%*
1,000	62.00%	30.00%	*54.57%*
10,000	80.00%	35.00%	*74.00%*
100,000	87.00%	40.00%	*80.14%*
1,000,000	92.00%	45.00%	*86.29%*
Average	*60.86%*	*27.14%*	*52.27%*

Figure 2. Probability of Serious Security Vulnerabilities in Software Applications. Source: Capers Jones © 2008

- For military projects, as one approaches systems the size of typical large combat systems (expressed as function points), the estimated number of security vulnerabilities rises to above 3000 and the probability of serious vulnerabilities rises to over 45%
- The statistics are much worse for civilian systems. As we move more and more into COTS and open source software for our combat systems, one might expect that the true extent of vulnerabilities in our systems would lie somewhere between those of military and civilian systems.

COTS and Open Source Exacerbate the Problem

- Reifer and Bryant [2] studied 100 packages were selected at random from 50 public Open-Source, COTS, and GOTS libraries
  - Spanned a full range of applications and sites like SourceForge
  - Over 30% of Open Source and GOTS (Government Off the Shelf) packages analyzed had dead code
  - Over 20% of the Open Source, COTS, and GOTS packages had suspected malware
  - Over 30% of the COTS packages analyzed had behavioral problems
- Reifer and Bryant conclude that the potential for malicious code in applications software is large as more and more packages are used in developing a system.

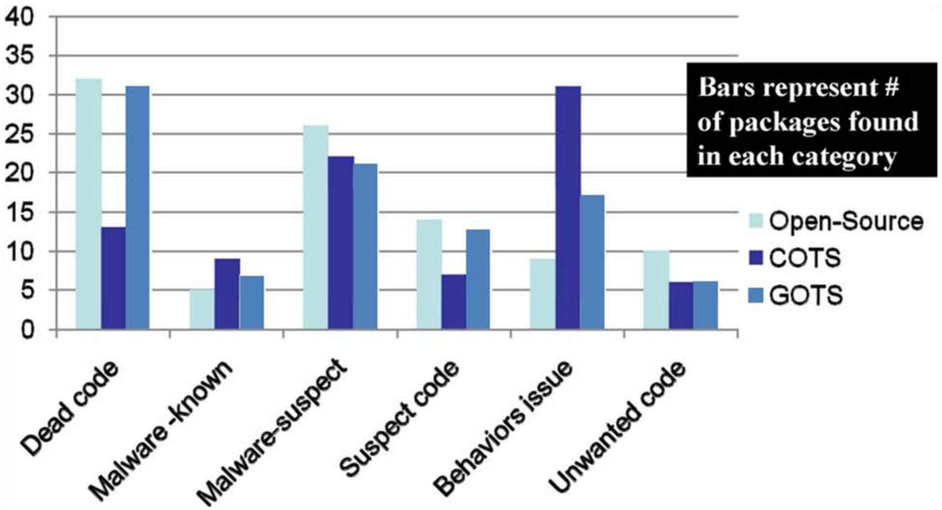


Figure 3. COTS Study Findings. *Source: D. Reifer and E. Bryant, Software Assurance in COTS and Open Source Packages, DHS Software Assurance Forum, October 2008*

DoD Clarifying Guidance Regarding Open Source Software (OSS) – October 16, 2009

2. GUIDANCE

a. In almost all cases, OSS meets the definition of "commercial computer software" and shall be given appropriate statutory preference in accordance with 10 USC 2377 (reference (b)) (see also FAR 2.101(b), 12.000, 12.101 (reference (c)); and DFARS 212.212, and 252.227-7014(a)(1) (reference (d))).

c. DoD Instruction 8500.2, "Information Assurance (IA) Implementation," (reference (g)) includes an Information Assurance Control, "DCPD-1 Public Domain Software Controls," which limits the use of "binary or machine-executable public domain software or other software products with limited or no warranty," on the grounds that these items are difficult or impossible to review, repair, or extend, given that the Government does not have access to the original source code and there is no owner who could make such repairs on behalf of the government. This control should not be interpreted as forbidding the use of OSS, as the source code is available for review, repair and extension by the government and its contractors.

d. The use of any software without appropriate maintenance and support presents an information assurance risk. Before approving the use of software (including OSS), system/program managers, and ultimately Designated Approving Authorities (DAAs), must ensure that the plan for software support (e.g., commercial or Government program office support) is adequate for mission need.

Source: DoD Chief Information Officer (CIO) Memorandum, "Clarifying Guidance Regarding Open Source Software (OSS) in the Department of Defense (DoD)," October 16, 2009

Testing vs. Static Code Analysis

- Testing requires code that is relatively complete
- Static analysis can be performed on modules or unfinished code [4]
- A static analysis tool is a program written to analyze other programs for flaws
  – Such analyzers typically check source code
  – A smaller set of analyzers can check byte code and binary code
- Manual analysis, or code inspection, can be very time-consuming, and inspection teams must know what security vulnerabilities look like in order to effectively examine the code
- Static analysis tools are faster and don't require the tool operator to have the same level of security expertise as a code inspector [5]

What Code Do You Analyze?

- How do you prioritize a code review effort when you have thousands of lines of source code, and perhaps object code to review?
- From a software assurance perspective, looking at attack surfaces is not a bad place to start [6]
  - A system's attack surface can be thought of as the set of ways in which an adversary can enter the system and potentially cause damage
  - The larger the attack surface, the more insecure the system [7]
  - Higher attack surface software requires deeper review than code in lower attack surface components.

Heuristics For Code Review – 1

- Howard proposes the following heuristics as an aid to determining code review priority [8]:
  - ***Old code***
    - Older code may have more vulnerabilities than new code because newer code often reflects a better understanding of security issues
    - Code considered "legacy" code should be reviewed in depth.
  - ***Code that runs by default***
    - Attackers often go after installed code that runs by default
    - Such code should be reviewed earlier and deeper than code that doesn't execute by default
    - Code running by default increases an application's attack surface
  - ***Code that runs in elevated context.***
    - Code that runs in elevated identities, e.g. root in *nix, for example, also requires earlier and deeper review because code identity is another component of attack surface.
  - ***Anonymously accessible code***
    - Code that anonymous users can access should be reviewed in greater depth than code that only valid users and administrators can access.

Heuristics For Code Review – 2

- ***Code listening on a globally accessible network interface***
  - Code that listens by default on a network, especially uncontrolled networks like the Internet, is open to substantial risk and must be reviewed in depth for security vulnerabilities.
- ***Code written in C/C++/assembly language***
  - Because these languages have direct access to memory, buffer-manipulation vulnerabilities within the code can lead to buffer overflows, which often lead to malicious code execution
  - Code written in these languages should be analyzed in depth for buffer-overflow vulnerabilities
- ***Code with a history of vulnerabilities***
  - Code that's had a number past security vulnerabilities should be suspect, unless it can be demonstrated that those vulnerabilities have been effectively removed.
- ***Code that handles sensitive data.***
  - Code that handles sensitive data to should be analyzed to ensure that weaknesses in the code do not disclose such data to untrusted users.
- ***Complex code.***
  - Complex code has a higher bug probability, is more difficult to understand, and may likely have more security vulnerabilities.
- ***Code that changes frequently.***
  - Frequently changing code often results in new bugs being introduced
  - Not all of these bugs will be security vulnerabilities, but compared with a stable set of code that's updated only infrequently, code that is less stable will probably have more vulnerabilities in it.

A Three-Phase Code Analysis Process – Phase 1

- Howard [6] also suggests a notional three-phase code analysis process that optimizes the use of static analysis tools.
  - **Phase 1 – Run all available code-analysis tools**
    - Multiple tools should be used to offset tool biases and minimize false positives and false negatives
    - Analysts should pay attention to every warning or error
      - Warnings from multiple tools may indicate that the code that needs closer scrutiny (e.g. manual analysis).
    - Code should be evaluated early, preferable with each build, and re-evaluated at every milestone.

A Three-Phase Code Analysis Process – Phase 2

- **Phase 2 – Look for common vulnerability patterns**
  - Analysts should make sure that code reviews cover the most common vulnerabilities and weaknesses, such as integer arithmetic issues, buffer overruns, SQL injection, and cross-site scripting (XSS)
  - Sources for such common vulnerabilities and weaknesses include the Common Vulnerabilities and Exposures (CVE) and Common Weaknesses Enumeration (CWE) databases, maintained by the MITRE Corporation and accessible at: http://cve.mitre.org/cve/ and http://cwe.mitre.org/
  - MITRE, in cooperation with the SANS Institute, also maintain a list of the "Top 25 Most Dangerous Programming Errors" (http://cwe.mitre.org/top25/index.html) that can lead to serious vulnerabilities
  - Static code analysis tool and manual techniques should at a minimum, address these Top 25

A Three-Phase Code Analysis Process – Phase 3

- **Phase 3 – Dig deep into risky code**
  – Analysts should also use manual analysis (e.g. code inspection) to more thoroughly evaluate any risky code that has been identified based on the attack surface, or based on the heuristics on Slides 9 and 10
  – Such code review should start at the entry point for each module under review and should trace data flow though the system, evaluating the data, how it's used, and if security objectives might be compromised

The Assurance Case

- An Assurance Case is a set of structured assurance claims, supported by evidence and reasoning that demonstrates how assurance needs have been satisfied [9]
  - It shows compliance with assurance objectives
  - It provides an argument for the safety and security of the product or service.
  - It is built, collected, and maintained throughout the life cycle
  - It is derived from multiple sources
- The Sub-parts of an assurance case include:
  - A high level summary
  - Justification that product or service is acceptably safe, secure, or dependable
  - Rationale for claiming a specified level of safety and security
  - Conformance with relevant standards and regulatory requirements
  - The configuration baseline
  - Identified hazards and threats and residual risk of each hazard and threat
  - Operational and support assumptions
- An Assurance Case should be part of every acquisition in which there is concern for IT security
  - Should be prepared by the supplier
  - Should describe
    - The assurance-related claims for the software being delivered,
    - The arguments backing up those claims,
    - The hard evidence supporting those arguments

Static Code Analysis in the Acquisition Life Cycle

System Engineering Technical Review Process (SETR)

- DoDI 5000.02, *Operation of the Defense Acquisition System* [10], describes the System Engineering Technical Review (SETR) process associated with the system acquisition life cycle.

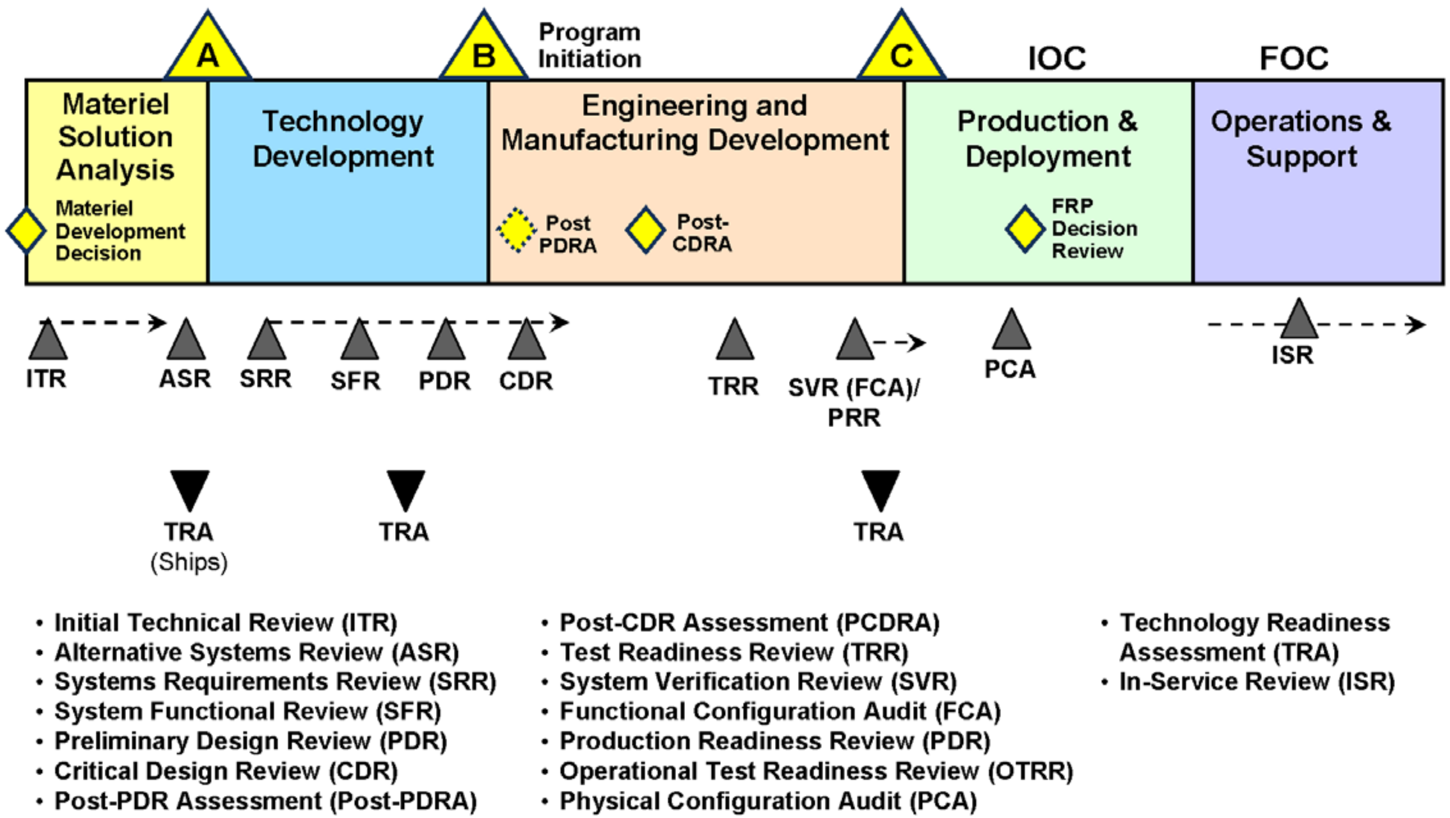


Figure 4. SETR Process

Software CI Reviews

- The reviews typically associated with software are shown below

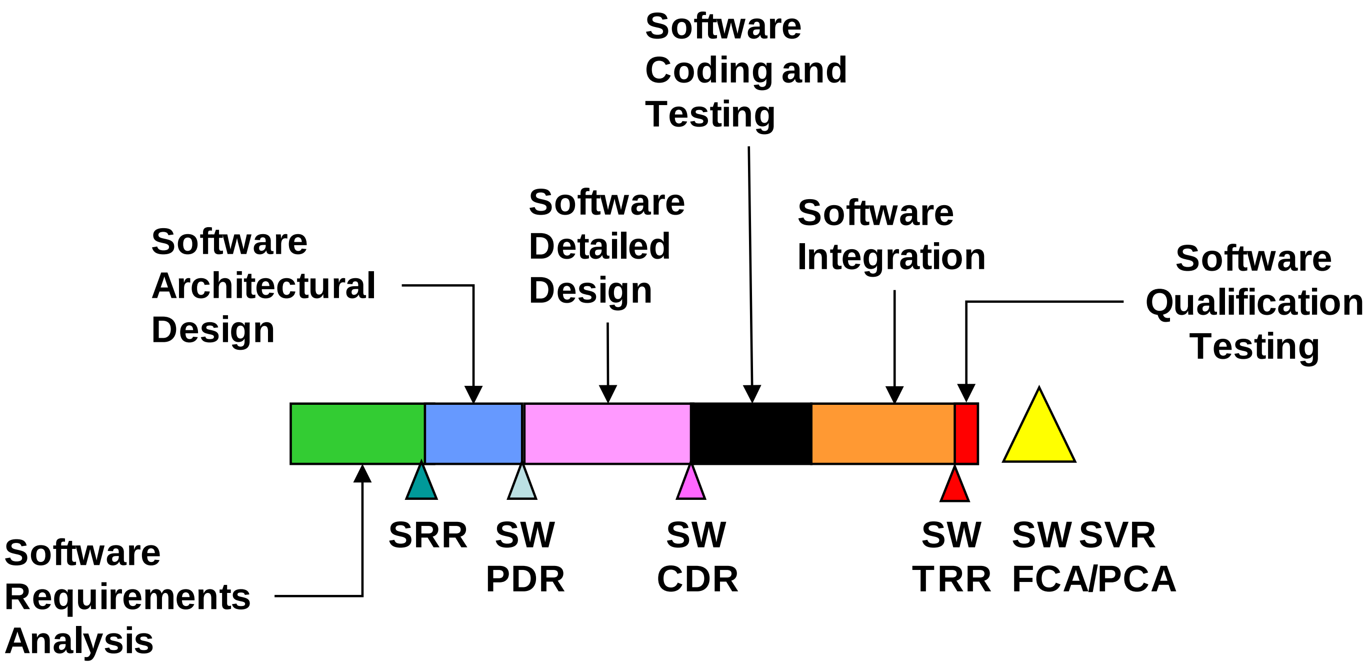


Figure 5. Software CI Reviews

Source: PEO IWS Technical Review Manual (TRM), December 2008

System Requirements Review (SRR) Objectives

- The SRR helps the PM understand the scope of the software assurance landscape (assurance requirements, elements to be protected, the threat environment) in which context static code analysis should be applied.

System Requirements Review (SRR) Outcomes

- Establishment of the System Assurance Case
  - Specification of the top-level system assurance claims that address identified threats to the mission.
  - Identification of the approach for developing the system assurance case.
- Identification of all critical elements to be protected
  - Identification of all relevant system assurance threats and their potential impact on critical system assets.
  - Identification of high-level potential weaknesses in the system
  - Determination and derivation of system assurance requirements (as a subset of the system requirements).
- Test and Evaluation Master Plan (TEMP) addressing system assurance
  - Examine the TEMP to ensure testing processes are sufficient for system assurance. This may include planning for static code analysis.
- Support and Maintenance Concepts
  - Documentation of the support and maintenance concepts including a description of how assurance will be maintained.
  - Description of what static code analysis tools will be used post deployment and how and when they will be applied

Preliminary Design Review (PDR) Objectives

- The PDR is a multi-disciplined technical review to ensure that the system under review can proceed into detailed design, and can meet the stated performance requirements within cost (program budget), schedule (program schedule), risk, and specific assurance requirements and constraints.

Preliminary Design Review (PDR) Outcomes – 1

- Information security technology evaluation of all critical COTS/GOTS elements
  - Performed as part of the analysis of alternatives.
  - Includes an updated assurance case based on the design, and new weaknesses and vulnerabilities identified.
  - Results of static code analyses performed of GOTS/COTS components.
    - Which tools were used?
    - What weaknesses and vulnerabilities were discovered
- Specification of assurance-specific static analysis
  - Specification of assurance-specific static analysis and assurance-specific criteria to be examined during code reviews
    - Code reviews performed during implementation
    - Documented in the System Engineering Plan (SEP) and Software Development Plan (SDP)
    - Plan for training to use static analysis tools and for manual analysis
- Configuration management
  - For Assurance, the preliminary configuration management plan must support traceability and protection of each configuration item, including requirements and architectural elements.
    - At what stages of the configuration management process will static code analysis be applied?
    - What configuration change events will trigger code analysis?
    - What components will be analyzed?
    - How will the results of the analyses be documented?

Preliminary Design Review (PDR) Outcomes – 2

- Supply Chain Assurance
  - For all critical elements being considered for procurement, an analysis of the supplier and its processes should be performed.
    - Will the supplier perform static code analysis as part of its code development and/or code integration processes?
    - Which components will be analyzed? Which will not?
    - What tools do they plan to use?
    - What are the details of their code inspection process for manual security analysis?
    - How will they mitigated any discovered vulnerabilities or weaknesses?
- Assurance Case
  - Updating of the assurance case with relevant evidence

Additional Preliminary Design Review (PDR) Considerations

- *COTS source code is rarely available to the acquirer for independent code review*
  - *PMs should request COTS vendors provide Assurance Cases for their COTS products detailing both the vendor's secure coding practices and the results of internal static code analysis or third party assessment (e.g. Common Criteria certification)*
  - *In cases where such information is unavailable, and there is still a desire to use the COTS component, the PM should consider binary code analysis*
  - *Such analysis could be performed either as part of the system integrator's life cycle process, or independently by an IV&V agent.*
- Ensure that a party other than the developer (such as a peer) will independently perform static analysis and test, and that the element being reviewed will be the element that will be delivered.

Critical Design Review (CDR) Objectives

- The CDR is a multi-disciplined technical review to ensure that the system under review can proceed into system fabrication, demonstration, and test, and can meet the stated performance requirements within cost (program budget), schedule (program schedule), risk, and specific assurance requirements and constraints.

Critical Design Review (CDR) Outcomes

- Identification and use of selected source code analysis tools
  - Selection of additional development tools and guidelines to counter weaknesses and vulnerabilities in the system elements and development environment(s)
    - These include static analysis tools for source code evaluation.
  - Definition and selection of assurance-specific static analyses and assurance-specific criteria to be examined during peer reviews performed during implementation.
    - Documented in the SEP and Software Development Plan (SDP).
  - Planning for training for assurance-unique static analysis tools and peer reviews.
  - Ensuring that another party (such as a peer) will independently perform static analysis and test, and that the element being reviewed will be the element that will be delivered
    - This counteracts the risk of a developer intentionally subverting analysis and test, as well as aiding against unintentional errors.
- Assurance Case
  - Updating of the assurance case with relevant evidence.

Test Readiness Review (TRR) Objectives

- The TRR is a multi-disciplined technical review to ensure that the subsystem or system under review is ready to proceed into formal test

Test Readiness Review (TRR) Outcomes

- Verification regarding static code analysis
  - Verification that assurance-specific static analysis and peer reviews of assurance criteria have been completed.
  - Verification that another party (such as a peer) performed static analysis and peer review.
  - Selection of any additional static analysis tools to identify or verify weaknesses and vulnerabilities in the system elements and development environment(s).
  - Completion and verification of an information security technology evaluation for all critical COTS/GOTS elements.
- Open source verification
  - Identification of industry tools and test cases to be used for the testing of any binary or machine-executable open source software products with no warranty and no source code.
  - Documentation of evidence that static analysis has been performed (both source and binary) to identify weaknesses and vulnerabilities such as buffer overruns and cross-site scripting issues.
- Assurance Case
  - Updating of the assurance case with relevant evidence

System Verification Review SVR/Production Readiness Review (PRR) Objectives

- The SVR is a multi-disciplined product and process assessment to ensure that the system under review can proceed into low-rate initial production (LRIP) and full-rate production (FRP) within cost (program budget), schedule (program schedule), risk, and other system constraints
- The PRR examines a program to determine if the design is ready for production and if the producer has accomplished adequate production planning
- The primary difference between PRR and TRR is that the system test results are available prior to PRR
  - If changes are made to the system in response to test results, it will be necessary to revisit TRR tasks
  - Any evidence provided by system test results should be incorporated into the assurance case prior to PRR

System Verification Review SVR/Production Readiness Review (PRR) Outcomes

- Verification regarding static code analysis
  - Verification that assurance-specific static analysis and peer reviews of assurance criteria have been completed.
  - Verification that another party (such as a peer) performed static analysis and peer review.
  - Selection of any additional static analysis tools to identify or verify weaknesses and vulnerabilities in the system elements and development environment(s).
  - Completion and verification of an information security technology evaluation for all critical COTS/GOTS elements.
- Open source verification
  - Identification of industry tools and test cases to be used for the testing of any binary or machine-executable open source software products with no warranty and no source code.
  - Documentation of evidence that static analysis has been performed (both source and binary) to identify weaknesses and vulnerabilities such as buffer overruns and cross-site scripting issues.
- Assurance Case
  - Updating of the assurance case with relevant evidence.

Operational Test Readiness Review (OTRR) Objectives

- The OTRR is a multi-disciplined product and process assessment to ensure that the “production configuration” system can proceed into Initial Operational Test and Evaluation with a high probability of successfully completing the operational testing
- Successful performance during operational test generally indicates that the system is suitable and effective for service introduction

Operational Test Readiness Review (OTRR)

- Verification regarding static code analysis
  - Re-verification that assurance-specific static analysis and peer reviews of assurance criteria have been completed.
    - Source code static analysis is typically not performed again for OTRR, but binary analysis is performed, if appropriate.
  - Re-verification that another party (such as a peer) performed static analysis and peer review.
  - Completion and verification of an information security technology evaluation for all critical COTS/GOTS elements.
- Weaknesses and vulnerabilities evaluation
  - Documentation of evidence that the system has been analyzed for weakness and vulnerabilities using static (binary) analysis tools to identify such flaws as buffer overruns and cross-site scripting issues
- Assurance Case
  - Updating of the assurance case with relevant evidence

In-Service Review (ISR) Objectives

- The ISR is a multi-disciplined product and process assessment to ensure that the system under review is operationally employed with well-understood and managed risk. This review is intended to characterize the in-service technical and operational health of the deployed system. It provides an assessment of risk, readiness, technical status, and trends in a measurable form

In-Service Review (ISR) Outcomes

- Configuration Management
  - Review of the configuration management process, to determine that it remains adequate with respect to analysis of code changes, and being followed
- Weaknesses and vulnerabilities evaluation
  - Documentation of evidence that any changes to the software throughout its service life have been analyzed for weakness and vulnerabilities using static (source or binary) analysis tools to identify such flaws as buffer overruns and cross-site scripting issues
- Assurance Case
  - Updating of the assurance case with relevant evidence

Challenges to Effective Static Code Analysis

Challenge – Procurement and Maintenance of Tools

- The better static code analysis tools are expensive
  - Use multiple tools used to offset tool biases and minimize false positives and false negatives can quickly become cost prohibitive for a single program
  - In addition, maintenance agreements to ensure a tool is up to date with respect to the spectrum of threats, weaknesses, and vulnerabilities add long term costs
- Buy it once, use it often provides the most bang for the buck
- Pooled-resources analysis labs may make economic sense.

Challenge – Training

- Static code analysis is not for sissies, although it may be for CISSPs (Certified Information System Security Professionals)
  - This tongue-in-cheek statement belies the difficulty in using static code analysis tools to their best advantage
  - Chandra, Chess, and Steven [12] point out that when static code analysis tools are employed by a trained team of code analysts, false positives are less of a concern; the analysts become skilled with the tools very quickly; and greater overall audit capacity results.
- In order to determine the validity of static code analysis results, it is important for PMs to understand
  - The level of training that code analysts have had with the tools employed for static code analysis
  - Their understanding of code weaknesses and vulnerabilities

Useful Links

- NIST SAMATE Static Analysis Tool Survey
  - The National Institutes for Science and Technology (NIST), Software Assurance Metrics and Tool Evaluation (SAMATE) project, provides tables describing current static code analysis tools for source, byte, and binary code analysis
  - More information on SAMATE can be found at http://samate.nist.gov/
- DHS Build Security In Web Site
  - A wealth of software and information assurance information, including white papers on static code analysis tools
  - More information on Build Security In can be found at https://buildsecurityin.us-cert.gov/daisy/bsi/home.html

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For More Information . . .

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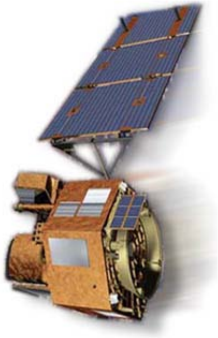
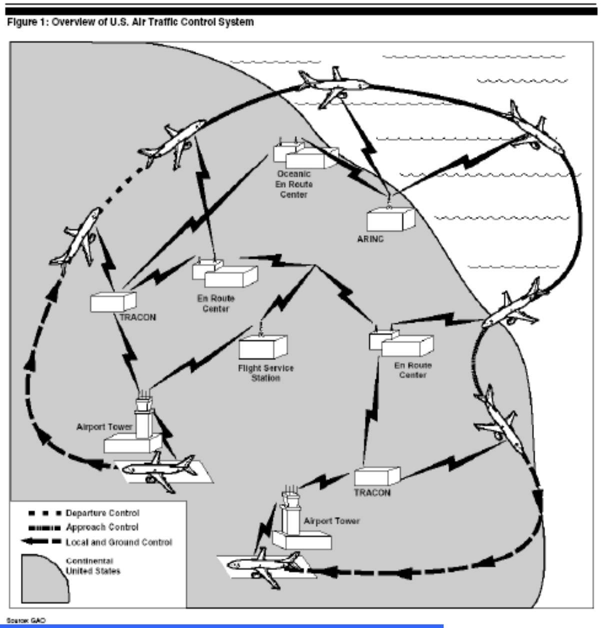


Achieving Acquisition Excellence - Making It Happen Effectively

Support Systems Associates, Inc. 800 Park Drive Warner Robins, GA 31088

"Achieving Acquisition Excellence via Effective Systems Engineering."
26 – 29 October 2009 San Diego, CA

29 October 2009



James E. Jones

Commitment to Excellence – Enabling acquisition organizations to achieve acquisition excellence

Content

Support Systems Associates, Inc. 800 Park Drive Warner Robins, GA 31088

- Objectives
- A Software Acquisition Journey
- Software Acquisition Challenges
- Key Acquisition Elements
  - The Contract
  - The Acquisition Environment
  - Requirements Management
  - Risk Management
  - Technical Performance Assessments
  - Software Test Evaluation
  - Performance Measurements
- Summary

Objectives

Support Systems Associates, Inc. 800 Park Drive Warner Robins, GA 31088

- Illustrate how effective Software Engineering Advisory and Assistance Services enable acquisition organizations to achieve acquisition excellence
- Provide Key Acquisition Elements for enabling acquisition excellence
  - The Contract, The Acquisition Environment, Requirements Management, Risk Management, Technical Performance Assessment, Software Test Evaluation, and Performance Measurements
- Provide detailed Practical Examples from major military and federal programs

Knowledge of failure helps lead to success

A Software Acquisition Journey

Support Systems Associates, Inc. 800 Park Drive Warner Robins, GA 31088

Programs	Roles
C-130 AMP ***Software Engineering Advisory and Assistance Services*** - ***8 years***	***Integrated Product Teams Support*** **Systems Integration Facility (SIF)** **Operational Flight Program (OFP) Software** **Systems Requirements, Design & Test**
C-130J Hercules ***Software Subcontract Management*** - ***4 years***	***Supplier Manager*** **Review and approve SDRL items** **Monitor supplier activities** **Witness acceptance testing** **Coordinate with FAA DER**
FAA NAS Plan Programs ***Software Engineering Advisory and Assistance Services*** – ***10 years***	**System Development Manager (AAS)** **SPO Software Lead (TDWR)** **Software Subject Matter Expert (e.g., VSCS, MLS[1], RCE[1], NADIN II, MCCP/MCC[2])** 1 Terminated for Default: Deposed by AT&T (RCE), GAO Audit (MLS) 2 Terminated for Convenience

Plus a foundation of 19-years Software Development and Process Improvement
United States Patents #4451702, #4479034

Examples of FAA NAS Programs

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Advanced Automation System (*AAS*) ***Cornerstone of the NAS Plan***	º 1984, $276.7 million Competitive Design Phase Contract – *IBM Federal Systems* and *Hughes Aircraft* º 1988, $3.6 billion Fixed-Price, – *IBM Federal Systems* Statement of Work º Replace computer hardware and software at ATC facilities-Airport Towers, Terminal Facilities, and En-Route Centers, 99.99999% Reliability.
Microwave Landing System (*MLS*)	º 1984, $90.6 million Fixed-Price First Production – *Hazeltine Corporation* System Overview º Landing aid to enable planes to fly a wide variety of approach paths to airport runways.
Radio Control Equipment (*RCE*)	º 1986, Fixed-Price Contract (DTFA01-86-C-00034) - *AT&T Company Federal Systems Advanced Technologies* System Overview º Provides pilots communications links with air traffic controllers.

Examples of FAA NAS Programs

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Voice Switching and Control System (VSCS) Upgrade 	º 1992-Contract Award-$1.3 billion, *Harris Corporation* System Overview º Allows air traffic controllers to communicate with pilots and other air traffic controllers at 23 Air Route Traffic Control Centers (ARTCC) º Independent distributed processors and voice switches, fault-tolerant databases, redundant high-speed bus interconnections, operational availability – 0.9999999
Terminal Doppler Weather Radar (TDWR) 	º 1988, Firm Fixed-Price Incentive contract – *Raytheon Systems Company* Develop, produce, and install 47 TDWR at 45 airport sites System Overview º Detects and reports hazardous weather in and around airport terminal approach and departure zones º Identifies and warns air traffic controllers of low altitude wind shear hazards caused by micro-burst and gust fronts º Reports on precipitation intensities º Provides early warning of wind shifts

Content

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  - Software Test Evaluation
  - Performance Measurements
- Summary

Software Acquisition Challenges

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➢ Why is Software Acquisition a Challenge?

- Studies have shown that ***technical performance, cost, and schedule risks*** are inherent in delivering quality software products within cost and schedule constraints [GAO 1999]
- 75% of all large scale software systems fail
  - [Software's Chronic Crisis, W Wyat Gibbs, 1994]
- Design constraints make software acquisition and development mission critical
  - **Examples of design constraints**
    - Application domain (real-time embedded systems of systems),
    - Software size
    - Complexity, Throughput/Timing
    - High-integrity
    - Reliability
    - Safety-critical

The Software Crisis Is Still With Us!

Software Acquisition Challenges

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- Why is Software Acquisition a Challenge?
  - Software size is the critical factor in determining cost, schedule, and effort [Jones 2004] [Jones 1999]
    - Software size typically driven by the supplier's agreement terms –
      - Contract vehicle (Fixed-Price, Cost-Reimbursement)
      - Statement of work
      - Deliverables (Contract Data Requirements List-CDRL)
      - Technical requirements (safety-critical)
      - Supplier's software development capability/maturity
  - Software Acquisition Team – Inability to recognize quality work

"Acquirers must recognize quality work before they can require and accept it"

----Watts Humphrey, 2009

Examples of Acquisition Problems

- Cost and Schedule Overruns
- Software Performance Issues
  - Underestimate software size and complexity
- Lack of Software Acquisition Capability Maturity
  - Ability to specify software contractual requirements
    - Functional and Non-Functional
  - Unable to recognize product quality
  - Lack of software expertise in acquisition, project management, and the application domain

Examples of Acquisition Problems

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FAA NAS Programs

o AAS	o Inadequate requirement baseline control o Cost and Schedule Overruns o Restructured in 1994 **– contract cost increased from $3.6 billion to $7.6 billion**
o NADIN II	o Cost and Schedule Overruns
o MCCP/MMC	o ***Termination for Convenience***
o MLS	o ***Termination for Default***
o RCE	o ***Termination for Default (DOT BCA No. 2479) (FAR 52.249-8)***

FAA NAS Programs

- **TDWR**[1]
  - Delivered First Production Unit ***six months early***
  - Received IEEE Computer Society award
  - Operational at 45 Airports
  - 1991, software process evaluated a SEI CMM® Level 3

® CMM registered in the U.S. Patent and Trademark Office by Carnegie Mellon University

Acquirer and supplier capability / maturity levels matched

- **VSCS Upgrade**
  - Production completed
  - 100% on-time system delivery of all 23 systems
  - FAA Contractor of the Year Award
  - Human Factors Engineering Society Award

1 *Successful Acquisition of FAA Terminal Doppler Weather Radar*, Third Annual Conference on the Acquisition of Software-Intensive Systems (Experience Track, 26 January 2004). [Jones 2004-1] http://www.sei.cmu.edu/programs/acquisition-support/conf/2004-presentations/jones.pdf

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- Objectives
- A Software Acquisition Journey
- Software Acquisition Challenges
- **Key Acquisition Elements**
  - The Contract
  - The Acquisition Environment
  - Requirements Management
  - Risk Management
  - Technical Performance Assessments
  - Software Test Evaluation
  - Performance Measurements
- Summary

The Contract

- Contract Administration
- Contract Types
  - Fixed-Price
  - Cost-Reimbursable
- Contact Data
  - Statement of Work (SOW)/Statement of Objective (SOO)
  - Contract Data Requirements List (CDRL)
  - System Specification
  - Data Rights

The Contract is the <u>foundation</u> for acquisition success

Contract Administration

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- The **Contract** is a mutually binding legal relationship obligating the seller (supplier) to furnish products or services and the buyer (acquirer) to pay for them.
- **Acquisition management** involves obtaining products or services through a contractual agreement.
- **Contractual authority** – delegated to an Administrative Contracting Officer (ACO)/procuring contracting officer (PCO)

The **acquirer** specifies
- What the system requires
- When the system is needed
- How the system will be accepted

Concerns
- cost
- schedule
- technical

The **supplier** determines
- How the system will be produced
- The resources required (examples)
  - people, equipment
  - facilities

The degree of interaction depends on the nature of the development effort and the type of contract

- Basic Compensation Schemes used in Contracts
  - ***Fixed-Price***
    - Acquirer pays the supplier a fixed sum
    - The supplier assumes the risk
    - Profit is a direct function of supplier’s ability to deliver the product or service
  - ***Cost-Reimbursement***
    - Acquirer agrees to reimburse the supplier’s allowable costs plus profit
    - The risk is shared

The degree of acquirer/supplier relationship depends upon the contract type

Contract Data

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- **Why have Contract Data?**
  - Contract vehicle must clearly express a vision of the final product and the development effort
  - Software acquisition issues must be addressed in the Request-For-Proposal (RFP) via contract data
- **Key *Software-Related* Contract Data in the RFP**
  - Statement of Work (SOW)/Statement of Objective (SOO)
  - Contract Data Requirements List (CDRL) Items
  - System Specification
  - Data Rights

Success of an acquisition is directly linked to the quality of the RFP --- (Army 2007)

SOW/SOO

- What is the Statement Of Work (SOW) / Statement Of Objectives (SOO)?
  - Basis for communicating acquirer requirements to the supplier
    - SOW defines specific tasks
    - SOO defines objectives
  - Primary document for translating management requirements into contractual tasks / objectives
  - Sufficient detail must be provided to allow the supplier to scope the effort, cost it, and provide a responsive technical solution
  - Tasking information must be defined for the preparation of deliverable data (artifact)
    - Each tasking statement reference applicable ***Contract Data Requirements List*** (CDRL) item which will be delivered by that task.

SOW/SOO

- Examples of Key Software Tasking
  - ***Software development process***
  - ***Software management***
  - ***Software engineering –*** software requirements analysis, preliminary design, detailed design, code and unit test, integration, and formal qualification testing
  - ***Software tools and environment***
  - ***Risk management***
  - ***Technical reviews –*** *Software Specification Review (SSR), Preliminary Design Review (PDR), Critical Design Review (CDR), and Test Readiness Review (TRR)*
  - ***Technical Interchange Meetings***
  - ***In Process Reviews***

The SOW/SOO must not tell the supplier how to do the required work
The SOW/SOO must not specify selection of major software components

Contract Data Requirements List (CDRL)

- Software Data (artifacts)
  - ***Absolutely essential*** for managing the development process
  - A natural by-product of the development effort to capture results of each activity
- Contract Data Requirements List (CDRL) Items
  - Primary vehicle for acquiring software data
  - A list of authorized data requirements for a specific procurement that forms a part of the contract.
  - Defense Federal Acquisition Regulation Supplement (DFARS) ***Subpart 215.470 Estimated Data Prices*** requires a CDRL (DD Form 1423) when delivery of data is required
  - CDRL items must be referenced in the Statement of Work (SOW) describing the development effort
  - Language must be consistent with the SOW

Key CDRL Item Requirements

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Block	Description
4	Authority (Data acquisition Documentation No.) Data Item Description (DID[1]) – Defines format and content preparation instructions for data product generated by task requirements ***Assist-Quick Search*** used to access the current DID 1 Should be tailored to meet contract requirements (Block 16)
5	Contract Reference - Reference Statement of Work paragraphs
6	Requiring Office – Organization have primary responsibility for reviewing the data and recommending acceptance/rejection of the data
8	Approval Code - (A) Approved by the Contracting Officer Should specify approval at each milestones (e.g., SSR, PDR, CDR, etc.)
10, 11, 12, 13	Delivery Requirements Should be associated with milestones (e.g., SSR, PDR, CDR, etc.) - 30 days prior to the milestone

CDRL Lessons Learned

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- Software CDRL items **should** be delivered prior to the technical reviews to allow significant time to enable:
  - Acquirer to perform a detailed review
  - Supplier to disposition the review comments
  - Acquirer to provide feedback to supplier disposition
- Technical review **should** include review of supplier disposition and feedback
- Software CDRL items **should** be prepared by the software team
  - Reviewed by all applicable distribution addressee organization
  - Approved by either the appropriate Chief Engineer, Program Manager or Data Requirements Review Board

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- Typical Software CDRL Items
  - **SOFTWARE REQUIREMENTS SPECIFICATION (SRS) –*DI-IPSC-81433A***
    - *Describes the behavior of the software to be developed and methods to be used to ensure each requirement has been met*
    - *Basis for the design and qualification*
    - **Interface Requirements Specification (IRS) – DI-IPSC-81434A may be appendix to SRS**
  - **SOFTWARE DESIGN DESCRIPTION (SDD) – *DI-IPSC-81435A***
    - *Describes the design and detailed design needed to implement the software*
    - **Interface Design Description (IDD)-DI-IPSC-81436A, may be appendix to SDD**
    - **Database Design Description (DBDD)-DI-IPSC-81437A, may be appendix to SDD**
      - *Describes the data base design and elements (content and format)*
  - **Software Test Plan (STP) – *DI-IPSC-81438A***
    - *Describes plans for qualification testing, test environment, identify tests to be performed, and schedule*
  - **Software Test Description (STD) –*DI-IPSC-81439A***
    - *Describes the test preparation, test cases, and test procedures to be used to perform the qualification testing*
    - **Enables the acquirer to access the adequacy of the qualification testing**
  - **Software Test Results (STR) – *DI-IPSC-81440A***
    - *A record of the qualification testing*
    - **Enables the acquirer to access the testing and its results**
  - **Software Version Description (SVD) – *DI-IPSC-81442A***
    - ***Identifies and describes a software version ("as-built" software)***

What is the System Specification?

- Establish top-level technical performance, design, development, integration, and verification requirements
- Examples of requirement statements
  - All software related to operation in civil airspace **shall** be modified or developed in accordance with the requirements of RTCA DO-178B or equivalent level of safety
  - All newly developed software **shall** be written in a higher order language (HOL)
  - Meteorological algorithms **shall** be implemented in high order language (HOL)
  - Use of commercial software **shall** be approved by the FAA

- Data Rights
  - Enable the use, maintenance, and replication of the software data
- Data Rights Categories
  - **Unlimited rights** - right to use, modify, reproduce, release, in whole or in part, in any manner and for any purpose whatsoever, and to have or authorize others to do so. Software developed exclusively with acquirer funds.
  - **Acquirer Purpose rights** - rights to use, modify, reproduce, release, within the acquirer's organization/company without restriction. Software development with mixed acquirer and supplier funding.
  - **Restricted data rights** apply only to noncommercial computer software and mean that the acquirer's rights are as set forth in a Restricted Rights Notice. Supplier funds all development .

Secretary of the Air Force Memo - Data Rights and Acquisition Strategy (3 May 06) - directing the acquisition of technical data and associated rights to be addressed specifically in all Acquisition Strategy Plans, reviews, and associated planning documents for Acquisition Categories (ACAT) programs – software intensive systems and subsequent source selections.

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The Acquisition Environment

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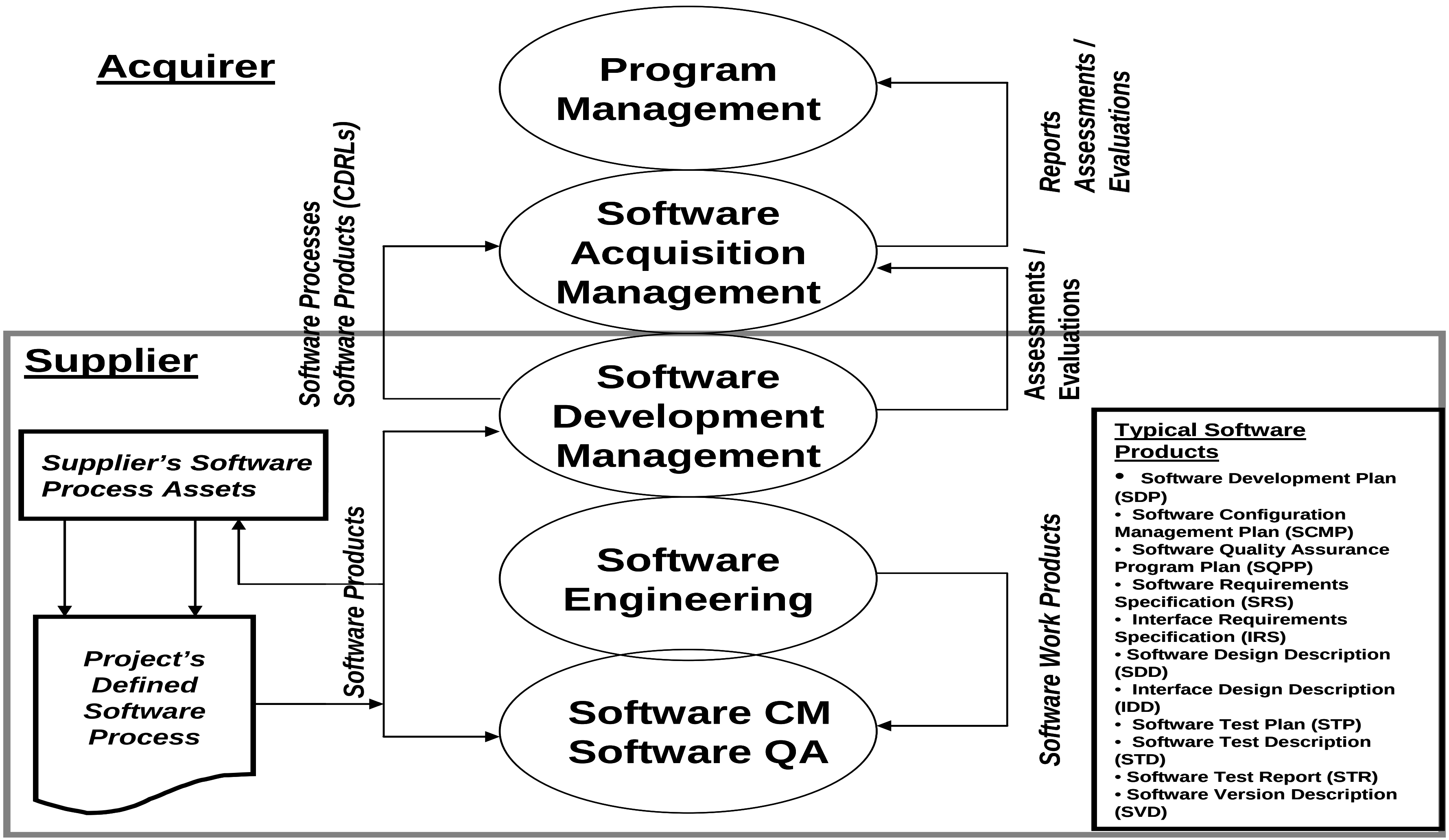

Best Practices: Better Matching of Needs and Resources, will lead to Better Weapon Systems Outcomes…GAO 2001

- Acquirer Capability Maturity
  - Software acquisition team must have software expertise in application domain, acquisition, process, project management, engineering, and safety, as needed
  - A software lead must be designated to be responsible for establishment and managing the software acquisition activities
  - The software acquisition team must have adequate resources and funding to perform the acquisition activities
  - The software acquisition team must be trained (Examples)
    - *Software Acquisition Management*
    - *Application domain (Radar, Communications Systems, etc)*
    - *Processes, Procedures, Standards being used*
    - *Technologies, Tools, Methodology being used*

"Acquirers must recognize quality work before they can require and accept it"

----Watts Humphrey

Example of FAA AAS SPO System Development

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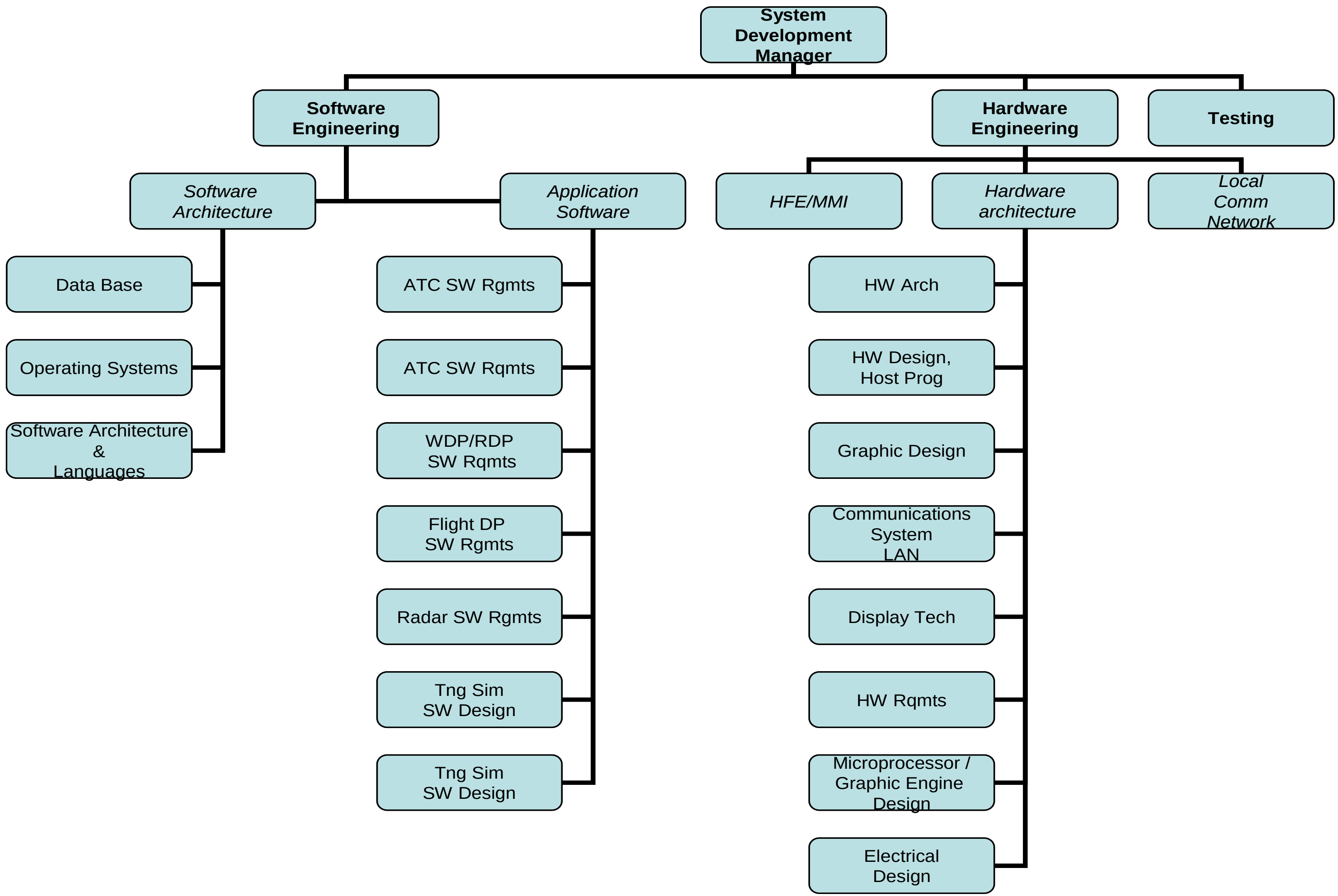

Supplier

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- Supplier Capability Maturity
  - A set of software process assets must be established and maintained
  - The project must develop a defined software process by tailoring the organization's standard processes
  - Software plans (**software development plan (SDP), software configuration management plan, and software quality assurance plan**) must be documented and institutionalized
  - The SDP must provide the acquirer with:
    - Insight into the processes, procedures, and desk instructions
    - Tools and methods used
  - Development environment must be augmented by management practices
    - Measuring and monitoring progress
    - Judging the quality of the software
    - Validating the deliverable
    - Conducting technical reviews and in-process reviews

Typical Software Process Definition

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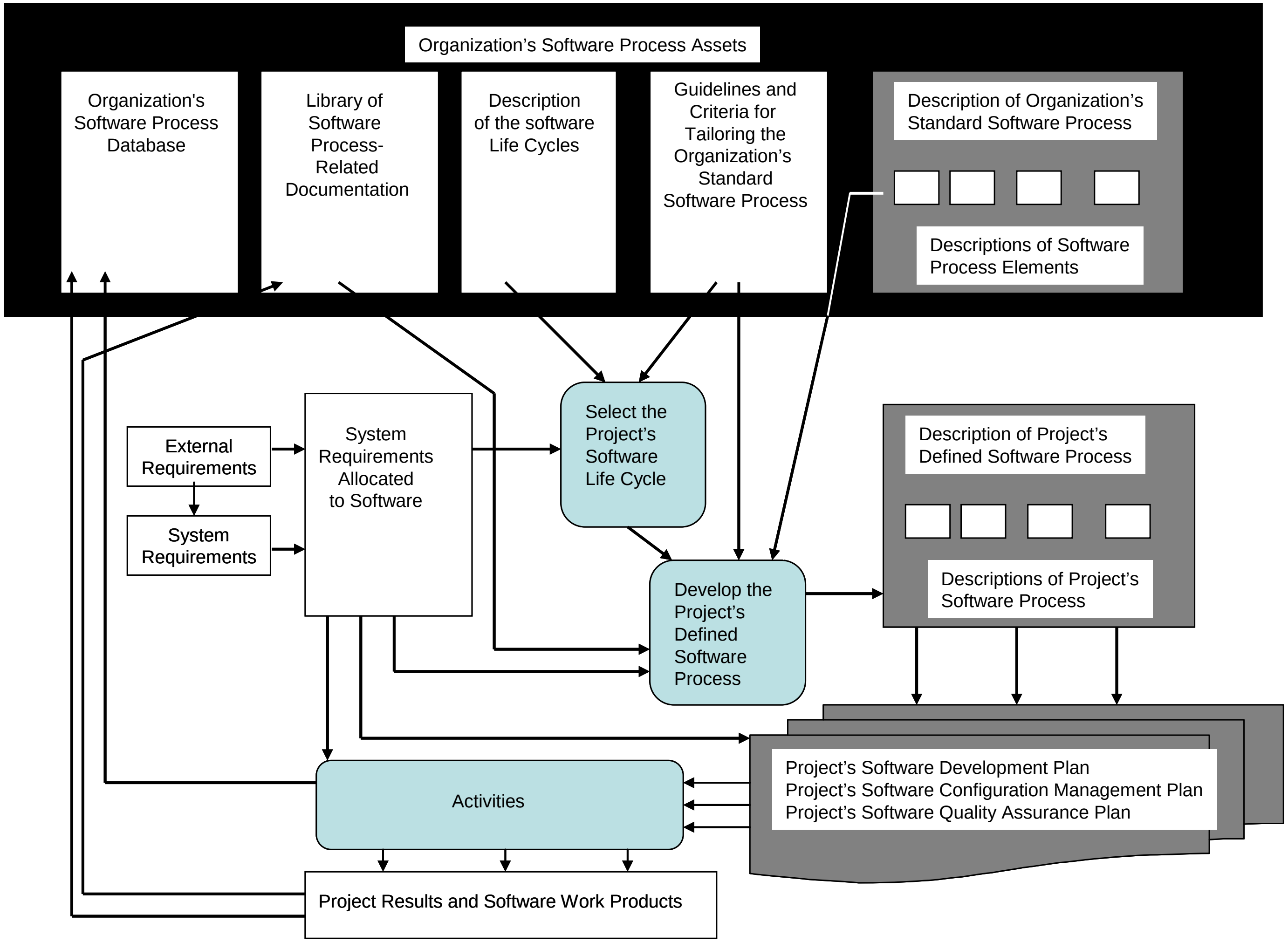

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- Requirements change for variety of reasons
  - Additional requirements are derived or changes made to the existing requirements
- ***Requirements Management*** involves establishing and maintaining bidirectional traceability of requirements, design, source code, and test to ensure the right product is being built
- Bidirectional traceability is required by CDRL item DID
- Bidirectional traceability is essential for Safety Critical
- Supplier must manage changes and identify any inconsistencies
- Supplier must track measures of requirements volatility

Requirements management is fundamental to a controlled and disciplined engineering design process [CMMI 2006]

Bidirectional Traceability

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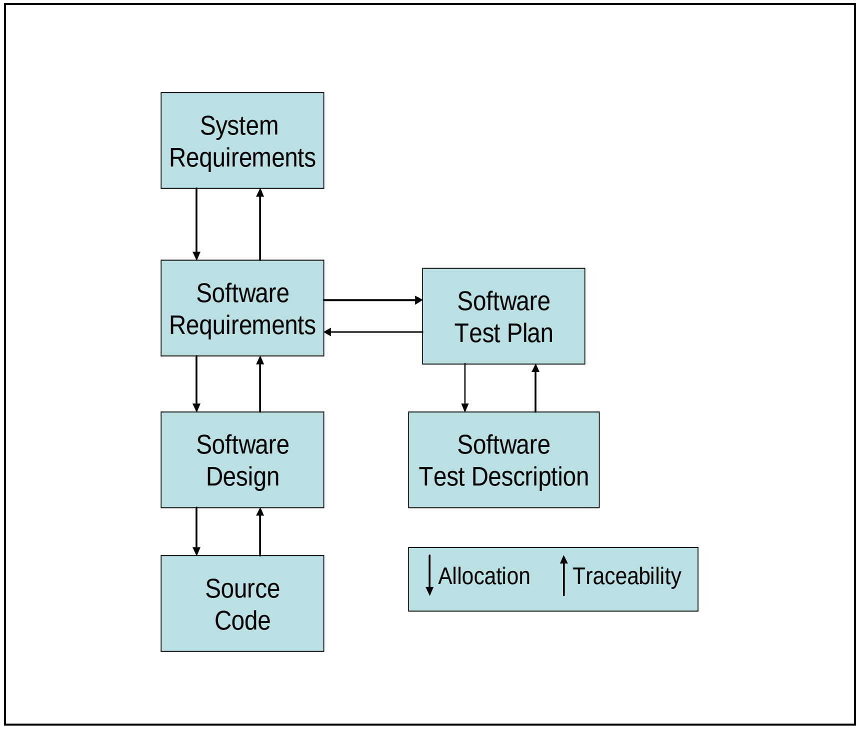
- Required by the CDRL item DID
- Allocation ensures the right products been built
- Reduce effort required to determine change impact
- Traceability ensures the evolving product is not expanding the scope
- Should be Documented in a requirements database
  - DOORS®, RTM



Bidirectional traceability

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- Why Manage Risks?
  - Risk is like fire: if controlled it will help you; if uncontrolled it will rise up and destroy you…
    - Theodore Roosevelt
  - ***Technical performance***, ***cost***, and ***schedule*** risks are inherent in software intensive systems development [GAO 1999]
  - One key obstacle is the inability to see cost and schedule issues as symptoms of unforeseen problems
    - Software size growth, requirements growth, complexity, ability to perform
  - Air Force expects the acquisition communities to address ***Risk Management*** throughout the life cycle of the acquisition program [DoD 2004]
    - Continuously identify and manage risks
    - Ensure the risks, impact, and mitigation plans are appropriately addressed during program reviews.
  - ***Risk Management*** is a process element of the 10 Life cycle Processes of Operational Safety Suitability and Effectiveness [AFMC 63-1201]
    - 1) Risk Management Planning, 2) Risk Identification, 3) Risk Assessment, 4) Identification of Risk Options, 5) Decision Analysis, 6) Implementation, and 7) Risk Monitoring

Risk Management

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➢ Managing Risks

- Establish a Risk Management Model to define a systematic process
- Establish consistent Risk Statement to allow recognition of the impact or consequence
- Establish a Risk Information System for identifying, analyzing, planning, tracking, and controlling risk.
- Risk Information System should include - storage media, the procedures, and the tools for accessing the risk system

Example of Risk Management Model ---[Van Scoy 1992],

Tools

- **MITRE**
  - •Risk Matrix
  - •Risk Management Toolkit
- **AFMC [AMC 2007]**
  - •Probability of Program Success (PoPS)

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- How to Reduce the Risks, Increase the Reliability and Quality, and Ensure Compliance with Requirements
  - Software work products (artifacts) are ***absolutely*** essential for managing the development process
  - Gaining adequate visibility into the supplies' process, plans, and software products is key to technical performance assessments
- Technical Performance Assessment provide:
  - **Visibility** into the process, quality and reliability of the software products.
  - Feedback to improve the software process
  - Ensures compliance with requirements
  - Key technical performance assessments
    - ***Process***
    - ***Progress***
    - ***Software Product***

Acquirers must recognize quality work before they can require and accept it

----Watts

Humphrey, 2009

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- **Process Assessment** - Ensure software management, engineering, configuration management, and quality assurance activities compliance with contractual requirements and supplier's defined software process and plans

Process Assessment key focus is "what is done and the product being built"

- Examples of Software Plans
  - Software Development Plan (SDP)
  - Software Configuration Management Plan (SCMP)
  - Software Quality Assurance Plan (SQAP)

The Contract must provide mechanism to gain access to process and plans

Technical Performance Assessment

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- Progress Assessment conducted to determine what is done
  - Contract SOW must specify Technical Reviews and Design Reviews to be held to determine progress, status, surface issues, and provide feedback. Examples:
    - **Technical Reviews (Examples)**
      - Program Management Review
      - Program Configuration Control Boards
      - Technical Interchange Meeting
      - In-Process
    - **Design Reviews** – used as quality gates (progress and quality)
      - (e.g., *Software Specification Review (SSR), Preliminary Design Review (PDR), Critical Design Review (CDR), etc*)
  - Supplier must conduct informal reviews such as Peer Reviews in accordance with supplier's defined process
  - Acquirer must participate in Technical Reviews and Design Reviews to
    - Gain visibility into the progress and status
    - Discuss issues/candidate risks
    - Provide feedback

Software Products Assessment

- Supplier must evaluate CDRL items prior to delivery and place under configuration control
- Supplier should deliver CDRL items prior to the technical review to allow significant time for detailed review and disposition of review comments
  - CDRL delivery and review comments disposition must be the entrance criteria for the technical review
- Acquirer must establish a CDRL review process
- Acquirer must complete the review within an agreed upon time after receipt of the CDRL items

- Acquirer typical review process
  - Evaluation CDRL using evaluation criteria
  - Evaluation criteria examples
    - Compliance with DID format and content
    - Completeness (e.g., missing requirements, testing, interfaces, etc.)
    - Traceability (e.g., test traced to requirements, etc.)
    - Consistency with upper level documents
    - Internal consistency
    - Ambiguity of requirements (understandable, testable?)
    - Conflicting requirements
    - Test coverage of requirements
    - Appropriate analysis, design, and coding techniques used
  - Provide discrepancies and recommendations to supplier
  - Conduct meeting with supplier to disposition supplier responses.

Practical Examples

- FAA NAS (TDWR) Contract
  - 16 CDRL Items specified by the SOW
  - Submittal (preliminary and final) linked to design review (e.g., SSR, PDR, etc)
  - Acquirer approval within 30-calendar days
- Raytheon
  - 45 Total CDRL Items delivered
- TDWR Software IPT
  - Over 4300 Review Items Discrepancies approved

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➢ What is Software Testing?

- Software development involves a series of activities in which opportunities for human induced defects are enormous
  - 46% - 60% of all software defects originate in the software requirements analysis phase [Endves 1975] [Voges 1979]
- **Software Testing** is the quality assurance technique used to evaluate the "as-built" software product to ensure the probability of failure due to latent defects is low enough for acceptance
- Software testing typically consists of three levels of testing
  - *Unit Testing*, *Integration*, and *Formal Qualification Testing*

Software testing represents the ultimate evaluation of the software requirements, design, and coding activities [Jones 1993-1]

Software testing can make the software product more reliable and usable [Musa 1987] [Dunn1984]

- What is required in the Contract?
  - Unit Testing, Integration, and Formal Qualification Testing (FQT) activities and artifacts must be documented in the supplier's defined software process and the Software Development Plan
  - FQT activities and artifacts must be specified in the SOW Examples
    - Planning – **Software Test Plan** (CDRL item)
    - Test Description – **Software Test Description** (CDRL item)
      - Test Cases and Test Procedures
    - Test Results – **Software Test Report** (CDRL item)
  - Test Readiness Review (TRR) must be held prior to FQT execution to determine readiness
  - Software test artifact must be delivered at designated quality gates (i.e., PDR, CDR, TRR, and Product Release)
- Acquirer and Supplier's Software Quality Assurance must witness all FQT execution

Problem Reporting/Tracking

- Supplier process must be institutionalized to:
  - Document problems identified during FQT and to track the problems to ensure closure
  - Determine the severity of all problems detected
  - Control changes to the software products under configuration control
  - Analyze the changes to determine impact to the work product, related work product, and schedule
  - Analyze the problem closure to determine the impact to the software release milestone

Change control system should be used to determine the aspects of process improvement and effectiveness of previous activities

Typical Problem Report Life Cycle

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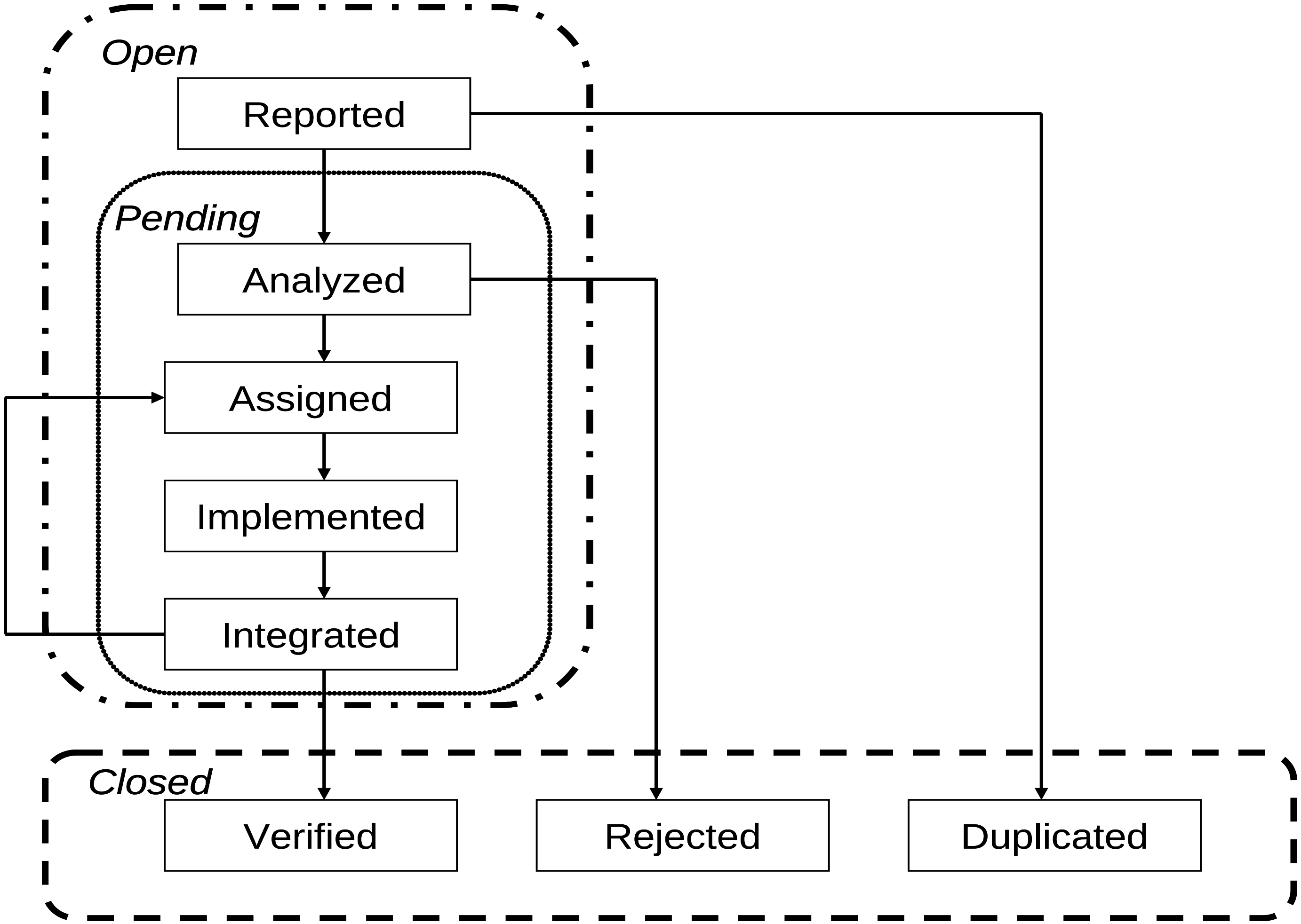

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How much testing is enough?

- Complete test coverage is generally not possible [Jones 1993-1]
- ***Test Case*** design methodology must be documented
- Acquirer and supplier must mutually agree on completion criteria Examples
  - Completion of a number of test runs with no open priority 1 and 2 severity problems
- Acquirer and supplier should establish a failure intensive objective (FIO) using a software reliability growth model: Examples
  - Time-Between-Failure Models
  - Error-Count Model

Acquirer and supplier face a difficult decision when to release the software product
Complete test coverage is generally not possible…[Jones 1993-1]

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Why Measure Performance?

- Software development is ***often out-of-control***. *You cannot control what you cannot measure*…[DeMarco 1982]
- **Performance Measurement** is key to managing and producing quality software and is an essential element of software process improvement [Humphrey 1989]
- National Defense Acquisition Act Section 804-2003 mandate
  - *Metrics for performance measurement and continual process improvement*

How to Measure Performance?

- *Software Measures* **should** be captured to document actual-versus-plan and to identify problems
- Software Measures **should** be selected that are directly measurable to evaluate progress and identify significant predictors [Jones 2004]
- Software Measures **should** be selected to provide insight into four key acquisition areas:
  - ***Process*** – insight into the software development process and how it is working
  - ***Product*** - insight into the quality of the product (frequency of requirement changes, number of problems, review comments)
  - ***Project*** - schedule attainment, CDRL delivery
  - ***Productivity*** - rate at which the work is progressing

Performance Measurement

- How to use Software Measures?
  - Provide overview of development progress
  - Early-warning for detecting process and quality issues
  - Provide feedback to refine the process and contribute to positive control
- Typical software measures
  - ***Software size***
  - ***Cost/Schedule deviation***
  - ***Schedule progress***
  - ***Activity progress***
  - ***Requirements stability***
  - ***Resource tilization***
  - ***Documentation (Artifact) review item discrepancies***

Examples of Performance Measures

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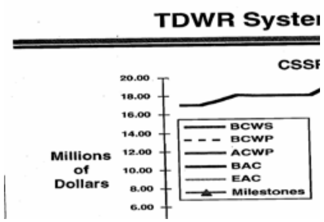
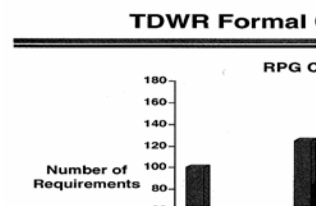
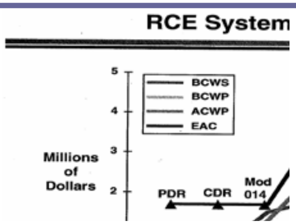


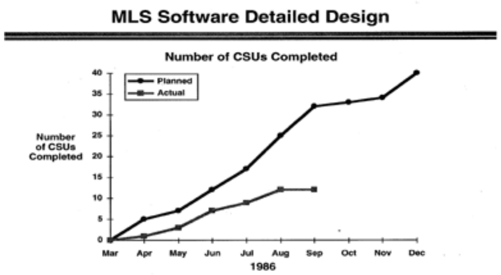


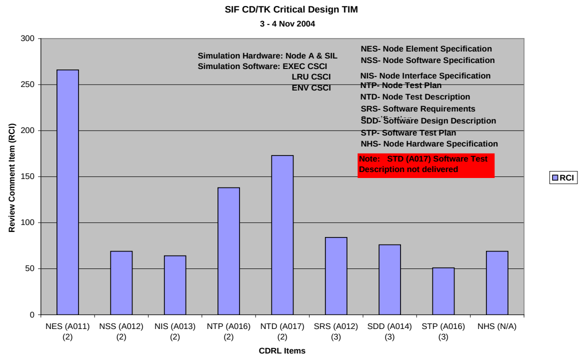
Cost/Schedule Deviation

FQT Progress

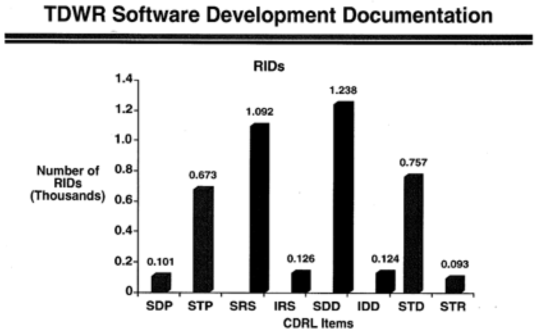


Development Progress





Document Review Item Discrepancies



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Achieving acquisition excellence…

- Receiving quality software delivered on time
  - THE CONTRACT ***must*** specify what is required
  - THE ACQUISITION TEAM ***must*** have the acquisition capability maturity to perform
    - **"Acquirers must recognize quality work before they can require and accept it"** ----Watts Humphrey, 2009
    - **The acquirer can negatively impact the supplier**
  - RISK MANAGEMENT ***must*** be performed to control the inherent performance, cost, and schedule risks
  - PERFORMANCE MEASUREMENTS ***must*** be performed to control the development activities

Summary

Support Systems Associates, Inc. 800 Park Drive Warner Robins, GA 31088

- Reducing the risks, increasing the reliability, and quality
  - TECHNICAL PERFORMANCE ASSESSMENTS ***must*** be performed to gain insight into the process and product quality
    - **Identify discrepancies in the process and products**
    - **Provide feedback to disposition of discrepancies**
    - **Vehicle for process improvement**
  - SOFTWARE TEST EVALUATION ***must*** be performed to ensure the "as-built" software product meets software requirements
  - REQUIREMENT MANAGEMENT ***must*** be performed to ensure the right product is being built at each phase throughout the lifecycle

Summary

Improvements in Software Acquisition

- Public Law 107-314 Section 804 of the National Defense Authorization Act, released in December 2002 [Section 804-2003]
- Clinger-Cohen Act: Initiatives such as Software Assurance and Open Architecture
- The best practice model Capability Maturity Model® Integration (CMMI®) for Acquisition
- The White House, Memorandum for the Heads of Executive Departments and Agencies, ***Government Contracting***, 4 Mar 09
  - [http://www.whitehouse.gov/the_press_office/Memorandum-for-the-Heads-of-Executive-Departments-and-Agencies-Subject-Government-Contracting/]

Questions ?

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James E. Jones

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Warner Robins, GA 31088

Email: jjones@ssai.org

Commitment to Excellence – Enabling acquisition organizations to achieve acquisition excellence

Selected Publications and Presentations

Support Systems Associates, Inc. 800 Park Drive Warner Robins, GA 31088

- *Software Acquisition Management Practical Experience*, Systems & Software Technology Conference, 22 April 2009
- *Process Improvement in a Small Company*, Proceedings of the First International Research Workshop for Process Improvement in Small Setting, October 25
- *Successful Acquisition of FAA Terminal Doppler Weather Radar*, Third Annual Conference on the Acquisition of Software-Intensive Systems, 26 January 2004
- *Mission Success: Estimating Software Projects*, The International Society of Parametric Analysts, 26th Annual Conference, May 10, 2004
- *Estimating Software Size, Cost, and Schedule: Mission Success Through Life Cycle Process*, 1999 Joint ISPA/SCEA Conference, 1999
- *Conforming to ISO 9001: A Mission Success Solution to Product Development,* Lockheed Martin Management and Data Systems, 1997
- *Software Metrics Effectiveness in Software Acquisition Management*, 38th Air Traffic Control Association Fall Conference, 1993
- *Software Testing: Methods and Techniques*, 38th Air Traffic Control Association Fall Conference, 1993
- *Software Acquisition Management: Managing The Acquisition of Computer Software Using DoD-STD-2167A*, 37th Annual Air Traffic Control Association Conference Proceeding, November 1992

Acronyms

Support Systems Associates, Inc. 800 Park Drive Warner Robins, GA 31088

AAS	Advanced Automated System
ACAT	Acquisition Category
AMP	Avionics Modernization Program
ATC	Air Traffic Control
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CIP	Capital Investment Plan
CNS/ATM	Communications/Navigation Surveillance / Air Traffic Management
CO	Contracting Officer
COTS	Commercial Off-The-Shelf
CPAF	Cost-Plus Award Fee
CSCI	Computer Software Configuration Item
CY	Calendar Year
DCI	Document Comment Item
DER	Designated Engineering Representative
DFARS	Defense Federal Acquisition Regulation Supplement
DID	Data Item Description
DoD	Department of Defense
DOORS	Dynamic Object-Oriented Requirements Systems
ECP	Engineering Change Proposal
EMD	Engineering, Manufacturing and Development
FAA	Federal Aviation Administration
FFP	Firm Fixed-Price
FFPI	Firm Fixed-Price Incentive

FQT	Formal Qualification Testing
IDD	Interface Design Description
IRS	Interface Requirements Specification
MP	Mission Processor
NAS	National Airspace System
OFP	Operational Flight Program
OFP	Operational Flight Program
PCO	Procuring Contracting Officer
PDR	Preliminary Design Review
SCM	Software Configuration Management
SDD	Software Design Description
SOF	Special Operations Forces
SOO	Statement of Objective
SOW	Statement of Work
SPO	System Program Office
SQA	Software Quality Assurance
SRS	Software Requirements Specification
SSR	Software Specification Review
STD	Software Test Description
STP	Software Test Plan
STR	Software Test Report
SVD	Software Version Description
TRR	Test Readiness Review

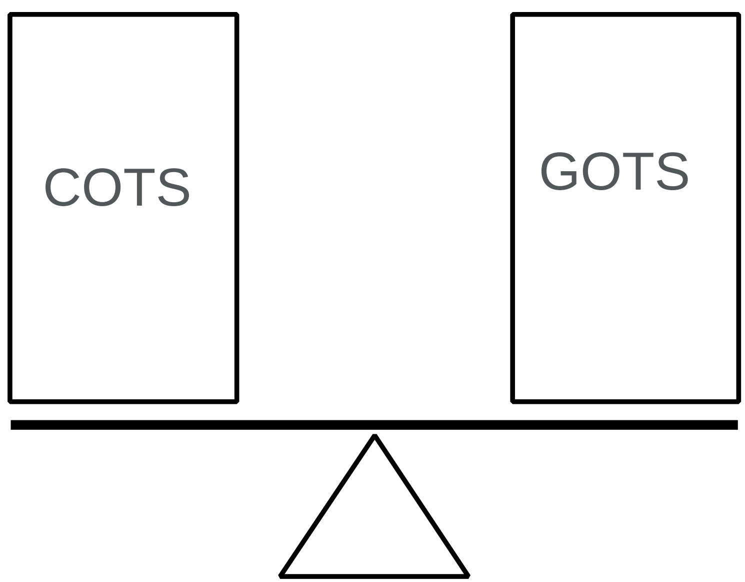
Toward Best Practices in Contracting for M&S

Presentation to the 12th Annual Systems Engineering Conference

Dennis Shea

Julie Nelson

29 October, 2009



Business Models

Work in progress

CNA ANALYSIS & SOLUTIONS

Plans for Acquisition and Requirements Reform

"DoD will expand and improve training programs in critical risk areas such as program execution, source selection, risk management, pricing and *contracting*." DoD will also increase resident training, ***expand simulations***, and continue to leverage e-learning technologies to improve its ability to deliver learning assets at the employee's point of need."

Memo for Assistant to the President for National Security Affairs
Robert M. Gates (SecDef)
April 6, 2009

How we got here

M&S Reuse Business Model recommendation

-- To strengthen reuse DoD should:

- Improve M&S-related contracting practices
  - Understand implications of procurement statues, regulations, policies etc on contracting for M&S-related products
  - Protect government “rights” to reuse, modify, share, M&S resources)
  - Develop RFPs with reuse in mind
  - Monitor M&S development process (avoid proprietary markings)
- Incorporate best practices in training for contract officers and PMs and other Gov’t M&S decision-makers
  - Match intended uses of M&S products and services with contracted deliverables including data rights

Objective

- Improve DoD M&S by publishing best practices for M&S-related contracting from a government perspective
  - Address full scope of contracting activities
  - Procurement of
    - M&S products (including databases) and services (including configuration management) and support tools
    - Larger project (weapon system, training service) where M&S is but an element
- Provide a roadmap to existing best practices and fill in gaps
  - Use front line experiences of acquisition force to assess what’s working well and what’s not
  - Use analysis to recommend changes to existing regulations, policies, and guidance to overcome challenges and promote efficiencies in contracting (benefit both government and industry)

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Background: Identified 8 activities in acquiring M&S

1. Determine M&S capabilities required to successfully execute the acquisition, planning, training, testing etc. task(s)
   – Identify well-defined M&S capability attributes to ensure that capability delivered meets user needs at an affordable cost
2. Use Discovery to determine if existing M&S resources satisfy required capabilities and are available for reuse
3. Source Selection Planning
   – Identify gaps in needed M&S capabilities
   – Determine how best to satisfy requirements (new development, existing commercial, or improved GOTS)
   – Assess potential for reuse and role, if any, for proprietary products
   – Develop source selection criteria (including maturity of firm's M&S capabilities)
   – Decide on level of data rights required and compliance with DoD policy on open architectures, HLA, VV&A, etc

Activities in acquiring M&S (continued 3-5)

3. Source Selection Planning (continued)
   - Assess interoperability and data interchange requirements and standards needed to satisfy requirements
   - Perform market survey to gauge qualifications of commercial vendors and government labs to develop needed M&S
4. Develop solicitation for M&S capabilities
   - Use results from source selection planning to develop RFP
5. Proposal Evaluation and Contract Award
   - Assess "best value" for government
   - Small business concerns
   - Type of contract
   - Special contract terms and conditions
   - Negotiate license terms and data rights
   - Negotiate deliverables

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Activities in acquiring M&S (continued 6-8)

6. Contract administration post award
   - Logbook of vendor's alternative funding sources for software employed to determine data rights
   - Resolving M&S to lowest component level (data rights)
   - Markings on software and database products
   - Government's responsibilities in protecting proprietary data
7. Acceptance of contract deliverables
   - Source Code, User Guide, Analyst Guide, VV&A
   - Quality and timeliness to support current (future?) users
8. Contracting for life-cycle maintenance of the M&S resource
   - Including multi-user licenses and other technical data rights
   - Including configuration management
   - Central funding for broadly used tools vs Program or PEO-unique needs

Today's discussion: Selecting M&S with reuse in mind (Activities 3-5)

- **General context:** DoD IT acquisitions, particularly M&S software (in context of a business model)
- **Policy:** Use commercial products whenever appropriate

  and

  Assess the long-term technical data needs
- **Issues to resolve:**
  - **Factors determining default rights ownership**
  - **Ambiguous guidance on appropriate scope of rights**
  - **Contracting context: licensing v. ownership of data rights**
- **Contract language examples**
  - **Problematic language**
  - **Consistent language**

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DoD FY08 IT obligations for products & services

(millions)	percent	GSA Product or Service Code
$10,938	57%	D -- IT services, including telecommunications services
$6,305	33%	70 -- General purpose information technology equipment
$783	4%	J -- Maintenance, repair & rebuilding of equipment
$379	2%	R -- Professional, admin, and mgmt support services
$378	2%	Other IT items
$260	1%	Other IT services
$19,043	**100%**	**Total**

Policy: Emphasize “commercial software”

United States Code: 10 U.S.C. 2377(a)

- The head of an agency shall ensure that procurement officials in that agency, to the maximum extent practicable, acquire **commercial items or nondevelopmental items** other than commercial items to meet the needs of the agency

Appropriations Legislation: FY09 NDAA

- The Secretary of Defense shall ensure that contracting officials identify and evaluate, at all stages of the acquisition process (including concept refinement, concept decision, and technology development), opportunities for the use of **commercial computer software and other non-developmental software.**

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Policy on “commercial software” (continued)

DoD Directive 5000.01 – “Most preferred” option for acquisition:

- E1.1.18.1. The procurement or modification of **commercially available products**, services, and technologies, from domestic or international sources, or the development of dual-use technologies.

DoD Instruction 5000.02

- 6. DoD ENTERPRISE SOFTWARE INITIATIVE. When the use of commercial IT is considered viable, **maximum use** of and coordination with the DoD Enterprise Software Initiative shall be made.

Importance of “data rights” in IT acquisitions

GAO (2006) finding:

- “The **lack of technical data rights** has limited the services’ flexibility to make changes to sustainment plans that are aimed at achieving cost savings and meeting legislative requirements regarding depot maintenance capabilities.”

Legislative Response – FY07 NDAA:

- The Secretary of Defense shall require program managers for major weapon systems and subsystems of major weapon systems to **assess the long-term technical data needs** of such systems and subsystems and establish corresponding acquisition strategies that provide for technical data rights needed to sustain such systems and subsystems over their life cycle.

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Factors determining default data rights ownership

- Relevant set of regulations: FAR v. DFARS
- Nature of product or service to be acquired: commercial v. non-commercial
- Nature of contracting process: commercial v. non-commercial
- Nature of contracting vehicle (contract, IDIQ, BPA, FSS, grant, SBIR, OTA, “special work”, etc)
- Specific terms of agreement

IT contract funding obligations – FY08

(millions)	Item or service	Commercial procedures Used	Commercial procedures *not* used	Grand total
$4,883	Commercially available item	77%	23%	100%
$932	Other commercial item	50%	50%	100%
$961	Non-developmental item	1%	99%	100%
$789	Non-Commercial item	5%	95%	100%
$7,575	Commercial service	58%	42%	100%
$3,904	Non-commercial service	3%	97%	100%
$19,043	Grand total	46%	54%	100%

DFARS guidance on acquiring data rights

Some regulations ***limit*** the scope of rights to be acquired:

DFARS 227.7102-1(a): Commercial technical data

– DoD shall acquire **only** the technical data customarily provided to the public with a commercial item or process

DFARS 227.7103-1(a): Noncommercial technical data

– DoD policy is to acquire **only** the technical data, and the rights in that data, necessary to satisfy agency needs.

DFARS 227.7202 and 227.7203 specify similar terms for software acquisitions

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USD(AT&L) guidance on “Other Transactions”

Other guidance specifies a maximal acquisition of data rights under certain type of agreements

- C2.3.3.3.2. Allocation of Rights. The agreement must explicitly address the government’s rights to use, modify, reproduce, release, and disclose the relevant technical data and computer software. The government should receive rights in **all technical data and computer software that is developed under the agreement**, regardless of whether it is delivered, and should receive rights in **all delivered technical data and computer software**, regardless of whether it was developed under the agreement.

Current Practices

- What works?
- What can be improved?
- Sources of information:
  - Recent RFPs – downloaded from INPUT (FedBizOps)
  - Recent contracts
  - Stakeholder interviews
  - Regulations, guidance and research

Sample INPUT RFP header

LIVE VIRTUAL CONSTRUCTIVE INTEGRATED ARCHITECTURE AND INFRASTRUCTURE PROGRAM (LVC IA)

Opportunity ID : 51733 **Mark as:** Not Marked

Opportunity Summary

Department:	ARMY
Agency:	ASST SEC FOR ACQUISITION, LOGISTICS AND TECHNOLOGY
Office:	PEO SIMULATION, TRAINING AND INSTRUMENTATION
Status:	Pre-RFP
Solicitation Release Date:	10/2009 (INPUT Estimate)
Award Date:	04/2010 (INPUT Estimate)
Solicitation #:	PEOSTRIKOCLVCIA
Value($K):	65,100
Competition Type:	GWAC / MAC / MAIDIQ
Primary Requirement:	System Design and Architecture
Duration:	2 year(s) base plus 4 x 1 year(s) option(s)
Contract Type:	Indefinite Delivery Indefinite Quantity
Primary NAICS Code:	
Place of Performance:	Orlando, FL
Opportunity Website:	Click to Visit Website
Updated :	09/09/2009

Procurement Timeline

Registration	12/01/2008
Conference	12/03/2008

Related Details

Key Contacts

Milton Washington 407-381-8854

Contracting Officer

PEO SIMULATION, TRAINING AND INSTRUMENTATION

Donald Stewart 407-384-5333

Administrative Point of Contact

PEO SIMULATION, TRAINING AND INSTRUMENTATION

Dave Bukovey 407-208-3398

Program Manager

PEO SIMULATION, TRAINING AND INSTRUMENTATION

More » **10 Total**

RFP and contract examples

- TRADOC Support: (Contract No: GS-00F-0014N)
- Modeling And Simulation and Analytically Based Warfare Analyses (Solicitation N00024-09-R-3145)
- Marine Corps Studies System (Solicitation M00264-06-D-0006)
- NMCI Transition Plan
- System Development and Demonstration (SDD) Phase for the Broad Area Maritime Surveillance (BAMS) Unmanned Aircraft System (UAS) Program (Solicitation 00019-07-R-0001)
- Engineering Technical And Support Services For Naval Warfare Center And Other NAVSEA Field Sites (Solicitation N00178-04-R-4000)
- F-16 Mission Training Center (MTC) Program (Solicitation FA8621-07-R-6291)
- BLCSE TECHNICAL SUPPORT EFFORT – Solicitation W912SU-07-R-0002

Insights

Problematic language

Very broad data rights claims by the government:

<u>Contract Example:</u> 17.0. Proprietary Rights. All proprietary rights to all materials produced by Contractor personnel shall become the sole property of the US Government.

<u>RFP Example:</u> As such, no analysis or data provided under this contract shall constitute or be construed as company proprietary or owned by the contractor. Upon termination of the contract, all related hardware, software, data and materials shall become property of the United States Government and shall not be disclosed except upon written authority by the Task Order Manager (TOM).

Problematic language: inconsistent clauses

Contract example:

H-13 Software and data rights

H-13.I. The Government shall be provided with unlimited rights to all data and automated models developed in support of this contract in accordance with the policy expressed in DFARS 227.71, and the requirements of DFARS Clause 252.227-7015, **Technical Data - Commercial Items**, and DFARS Clause 252.227- 7013, Rights to Technical Data - Noncommercial Items. Proprietary models must not be used for any task order under this contract without the specific, written approval by the COR, prior to start of any work.

Problems:

- The commercial items clause (‘7015) cited above does ***not*** specify *unlimited* data rights for the government.
- All of the clauses cited explicitly ***exclude*** computer software (contrary to the implication of the section title).

Problematic language (continued)

Contract example:

H-14.2. DFAR22.227-7013 (June 1995) Rights in technical data and computer software shall apply to those monthly reports and other documents that are not characterized as "Special Works.“

Problems:

- Clause DFAR22.227-7013 does not exist.
- Clause DFARS 252.227-7013 does not apply to computer software.

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Problematic language: Transition planning

1. DEFINITIONS.

a. **Contractor Proprietary Software** means computer software that is owned by Contractor and used solely by Contractor in providing ZZZZ Services, and includes Related Software Documentation…

f. **Licensed Software and Other Intellectual Property** means Contractor Proprietary Software and Other Intellectual Property for which the Government has negotiated and paid for a license to use.

k. **Other Intellectual Property** means intellectual property, other than proprietary software, relating to the design and operation of the ZZZZ that is owned by Contractor.

2.4 MARKING OF CONTRACTOR INTELLECTUAL PROPERTY AND PROPRIETARY INFORMATION.

Contractor shall conspicuously and legibly mark, and **the Government shall not remove**, the below legend on hard or soft copies of documents and other tangible embodiments of Contractor Proprietary Software and Other Intellectual Property to which such access or license is granted to Government.

Problematic language – transition planning (continued)

3.6 TRANSITION OF CONTRACTOR PROPRIETARY SOFTWARE AND OTHER INTELLECTUAL PROPERTY.

(a) Government Option to License Contractor Proprietary Software and Other Intellectual Property: Government or its Successor Contractor(s) may desire rights to Use the Contractor Proprietary Software and Other Intellectual Property to perform the ZZZZ Services after this Contract expires or is terminated. **The Government may elect to acquire from Contractor a specifically negotiated license to use all, or a part of, Contractor's Proprietary Software and Other Intellectual Property upon the terms and conditions set forth herein**.

(d) **License; Reservation of Rights.** If Government elects to a acquire license to use the Licensed Software and Other Intellectual Property, the Government and Contractor shall enter into a mutually acceptable license agreement pursuant to which, upon payment of the mutually agreed upon license fee (the "License Fee"), said license shall become effective. **Contractor reserves all rights not expressly granted in the license. Nothing in this Contract conveys, or shall be construed to convey, any right of ownership of Contractor Proprietary Software and Other Intellectual Property to Government or to its Successor Contractor(s).**

Consistent language – scope of rights

RFP Example: **Technical Data Package/Rights** -

- **Provide the appropriate SOW tasking** in Annex F **for delivery of the technical data and rights sufficient to accomplish the objectives in SOO** paragraph 3.1.3.4 and, in this paragraph, demonstrate the extent to which the objectives can be met.
- **Provide a description of the level of data and rights** separately with regard to (a) meeting Title 10 U.S.C., Chapter 146, Section 2464, CORE logistics capabilities (CLIN 0101); (b) a competitively selected PBL support environment (CLIN 0102); and (c) the source data and data rights for a mission control system to enable use and modification for other UASs (CLIN 0103).
- For each, the Offeror **shall propose their approach for providing technical data** from both the prime and subcontractors, with sufficient rights and licenses provided to the Government. Specifically identify the data and the rights that will be provided, clearly identifying the additional data and rights to be provided that are above what will be provided as part of the effort under CLINs 0002 and 0202. Also, if any, identify data and rights that are required to meet the objectives but will not be provided.

Consistent language – classifying deliverables

RFP Example: **Intellectual Property Deliverable Restrictions**.

For each task order to be issued under the contract, the Contractor shall identify, prior to award of the affected task order(s) to the best of its ability, noncommercial and commercial technical data and computer software that it intends to deliver with restrictions on the Government's right to use, release or disclose such identified technical data and/or computer software.

Consistent language – Cost of data rights

RFP Example: 7.2.2.9 Software Parametric Data.

…Software costs shall be included in the Basis of Estimate (RFP Section J Attachment 18), including, license costs for COTS items, and costs for providing Government unlimited rights for software developed by the offeror and its suppliers.

Lessons learned thus far:

- Request appropriate level of data rights (don’t ask for the universe!)
- Use contract language that recognizes the contractor’s copyright ownership
- Discuss data rights issues at the beginning of the contract
- Plan for a smooth transition at the end of a contract (avoid a hostage crisis)
- Consider a repository (virtual) to hold data rights

Ongoing activities

- Extend analysis of RFPs and contracts to requirements, contractor qualifications, deliverables, …
- Interview PMs, M&S leads, Gov model mgrs, COR
- Survey industry for recommended best practices
- Suggest clarifying and simplifying language for acquisition guidance

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Backup slides

What distinguishes a "Best Practice" for M&S Contracting?

- Complies with established policy, regulations, statutes
- Avoids post-award protests
- Achieves PM's objectives
  - Program cost/schedule/performance
- M&S completes on time/schedule
- Leads to successful use of M&S
- Balances government and industry interests
- Supports broader DoD M&S aims
  - Reuse, agile, adaptable, open, interoperable

Contracting context: works of federal *employees*

The U. S. Code does not extend protection to works of the federal government:

- **17 USC § 105:** Copyright protection under this section is not available for any work of the United States Government…
  - A "work of the United States Government" is a work prepared by an ***officer*** or ***employee*** of the United States Government as part of that person's official duties.

Thus we must look elsewhere to identify the data rights retained by federal ***contractors.***

Contracting context: works of federal *contractors*

17 USC § 105: …but the United States Government is not precluded from receiving and holding copyrights transferred to it by assignment, bequest, or otherwise.

In other words, the ownership of technical data rests with the contractor unless explicitly transferred.

However, DFARS does not necessarily require this assignment:

227.7103-4 License rights for non-commercial technical data.

- (a) *Grant of license*. The Government obtains rights in technical data, including a copyright ***license***, under an irrevocable license granted or obtained for the Government by the contractor. **The contractor or licensor retains all rights in the data not granted to the Government.** For technical data that pertain to items, components, or processes, the scope of the license is generally determined by the source of funds used to develop the item, component, or process. When the technical data do not pertain to items, components, or processes, the scope of the license is determined by the source of funds used to create the data.

Problematic language

Overly broad data rights claims by the government:

<u>Contract Example:</u> 17.0. Proprietary Rights. All proprietary rights to all materials produced by Contractor personnel shall become the sole property of the US Government.

<u>RFP Example:</u> As such, no analysis or data provided under this contract shall constitute or be construed as company proprietary or owned by the contractor. Upon termination of the contract, all related hardware, software, data and materials shall become property of the United States Government and shall not be disclosed except upon written authority by the Task Order Manager (TOM).

Consistent language – classifying deliverables

RFP Example: **Intellectual Property Deliverable Restrictions**.

For each task order to be issued under the contract, the Contractor shall identify, prior to award of the affected task order(s) to the best of its ability, noncommercial and commercial technical data and computer software that it intends to deliver with restrictions on the Government's right to use, release or disclose such identified technical data and/or computer software.

GOTS vs COTS Business Models

Positive

GOTS

- Designed to meet specific requirements
- Information Assurance (IA) built in
- Fewer barriers to reuse (Unlimited rights)

COTS

- Potential for reduced cost/schedule
- Potential for multiple alternatives
- Leverage improvements from broader marketplace
- Leverage experiences fm wider user base

Negative

GOTS

- Potential cost/schedule overruns
- Potential loss of innovation

COTS

- May not fully meet program requirements
- Greater integration risks with multiple vendors
- No visibility inside product
- Vendor stability
- Dependence on license agreements
- DoD unable to dictate product improvements

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DFARS license rights for technical data & software

- **DFARS 227.7103-9(a)(1):** The clause at 252.227-7013, Rights in Technical Data--Noncommercial Items, requires a contractor to grant or obtain for the Government ***license rights*** which permit the Government to reproduce data, distribute copies of the data, publicly perform or display the data or, through the right to modify data, prepare derivative works.

- **DFARS 227.7203-9(a)(1):** The clause at 252.227-7014, Rights in Noncommercial Computer Software and Noncommercial Computer Software Documentation, requires a contractor to grant, or obtain for the Government ***license rights*** which permit the Government to reproduce the software or documentation, distribute copies, perform or display the software or documentation and, through the right to modify data, prepare derivative works.

Data rights under FAR

27.403 Data rights—General.

- All contracts that require data to be produced, furnished, acquired, or used in meeting contract performance requirements, must contain terms that delineate the respective rights and obligations of the Government and the contractor regarding the use, reproduction, and disclosure of that data.

27.404-3 Copyrighted works

- (a)(1) Generally, the contractor must obtain permission of the contracting officer prior to asserting rights in any copyrighted work containing data first produced in the performance of a contract. However, contractors are normally authorized, without prior approval of the contracting officer, to assert copyright in technical or scientific articles based on or containing such data that is published in academic, technical or professional journals, symposia proceedings and similar works

Data rights under FAR 52.227-14

(2) The Contractor shall have the right to—

- (i) Assert copyright in data first produced in the performance of this contract to the extent provided in paragraph (c)(1) of this clause;
- (ii) Use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Contractor in the performance of this contract, unless provided otherwise in paragraph (d) of this clause;

(c)(1) Copyright— (1) Data first produced in the performance of this contract.

- (i) Unless provided otherwise in paragraph (d) of this clause, the Contractor may, without prior approval of the Contracting Officer, assert copyright in scientific and technical articles based on or containing data first produced in the performance of this contract and published in academic, technical or professional journals, symposia proceedings, or similar works. The prior, express written permission of the Contracting Officer is required to assert copyright in all other data first produced in the performance of this

(d) *Release, publication, and use of data.*

The Contractor shall have the right to use, release to others, reproduce, distribute, or publish any data first produced or specifically used by the Contractor in the performance of this contract, except—

- (1) As prohibited by Federal law or regulation (*e.g.*, export control or national security laws or regulations);
- (2) As expressly set forth in this contract; or
- (3) If the Contractor receives or is given access to data necessary for the performance of this contract that contain restrictive markings, the Contractor shall treat the data in accordance with such markings unless specifically authorized otherwise in writing by the Contracting

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Data rights for project involving OneSAF

- 3.3.1 Within scope of TICC and BEST activities (paragraph 3.1.1 above) the contractor shall modify, integrate and/or install simulation-independent HLA Middleware software packages, Gateways, Adaptors or Interfaces, permitting existing BLCSE simulations to interact with 3CE and/or Lead System Integrator (LSI) federates. Middleware, Gateways, Adaptors and Interfaces not provided as GFE **will be developed and delivered with complete documentation, operating instructions, and with complete government proprietary rights.** OOS-based or developed, or other GFE available, Middleware, Gateways, Adaptors and Interfaces will be utilized unless prior written agreement is received from COTR that no OOS or other GFE Middleware, Gateways, Adaptors and Interfaces are available or suitable to the integration task.

Data rights for project involving NSS, STORM

RFP Example: As such, no analysis or data provided under this contract shall constitute or be construed as company proprietary or owned by the contractor. Upon termination of the contract, all related hardware, software, data and materials shall become property of the United States Government and shall not be disclosed except upon written authority by the Task Order Manager (TOM).

Process management and tool selection to minimize risk of hand-arm vibration syndrome

NDIA Systems Engineering Conference- October 26-29, San Diego, CA

Mark Geiger, MS., CIH, CSP

Navy Safety Liaison Office (OPNAV N09FB)/Naval Safety Center

Presented by

Mr. Sherman Forbes

SAF/AQRE Acquisition ESOH Risk Management

Outline

- Hand-arm vibration (HAV) - Background
  - Under-recognized occupational disease
  - Potential for prevention
- Defense Safety Oversight Council
  - Project objectives
- Anti-vibration gloves
- Power tools
- Challenges

What is Hand-Arm Vibration?

- Energy into the hands/arms from vibrating tools
- Important Factors:
  - magnitude
  - direction
  - frequency

What is the Deal?

- Hand/arm vibration exposure can be excessive in the workplace
- Many highly exposed groups have incidence of disease in the range of 10 to 50%
- Poorly recognized – improvements often limited or absent
  - Quarry workers studied in 1918 has 80% incidence of disease
  - Follow-up in late 1970s showed same tool, similar disease incidence and included some grandson's of original study group
- Many of the exposures can be reduced significantly.
- Lowering hand/arm vibration can have several benefits

Health Effects
Hand-Arm Vibration (HAV) Syndrome

Disease States:

- Reynaud's Phenomenon of Occupational Origin
- Carpal Tunnel Syndrome
- Bone and Joint Disorders
- Neurological Disorders

Hands of vibrating pneumatic hand-tool operator in later stages of irreversible Hand Arm Vibration Syndrome1

Hand Power Tool Use in the Department of Defense

TOOL TYPE	PRIMARY PROCESSES INVOLVED					
	Maritime / Shipyard	Construction	Aircraft and Vehicles Mx	Ground/Road and Facility Maintenance	Forestry	Mining/ Milling/ Quarry
Grinders	X	X	X			
Polishing	Limited	Limited	XX			
Welding and Pre-Post Grinding	XX	X	X		Limited to Support Ops	X
Mechanical Metal Cutting	X Submarine Recycling	XX	X	X Concrete Work		XX
Wood Cutting/Finishing	X (support structures)	XX		X	XX Chain Saws	X (Support Structures)
Concrete Work; Finishing and Set-up, Cutting				XX Mixers, Jackhammers		
Impact Wrenches	X	X Riveting and Airframes Maintenance	XX Tires and Wheel	X		XX Assembly
Demolition	X			XX Jackhammers	X (Tree Stump and Rock Removal)	XX
Foundry Operations and "Finishing" Cast Work	X		Limited			Support areas
Drilling	X	XX	XX	XX	X	XX
Stone Cutting		XX		XX	X	XX Quarry Work

Metrics and Outcome

Metrics & Outcome: The occupational exposure limits for hand-arm vibration demonstrate a very good correlation between exposures to vibration (measured as acceleration) and the incidence/ prevention of disease. An example from the forestry industry is provided below (Koskimies et al 1992)

Equipment type (Chain Saw)	Vibration	Prevalence of HAV
Existing equipment (unimproved) (1972)	14 m/s2	40%
Anti-vibration design	2 m/s2	5% (1990)

Hand-Arm Vibration Standards

- ISO 5349-1986

  Guidelines for measurement and evaluation

- ISO 8662-5-1992

  Handle measurement pavement breakers/hammers

- ANSI S3.34-1986

  Guidelines for measurement and evaluation

- ACGIH-TLV

  Guidelines for evaluation and control

ACGIH Hand/arm Vibration TLV

Total Daily Exposure Duration	**Acceleration Level (m/s^2)**
4 hours and less than 8	4
2 hours and less than 4	6
1 hour and less than 2	8
Less than 1 hour	12

Discussion

- Productivity increases when vibration/ ergonomic equipment/tools are incorporated into a process
- Injuries and disability are expensive, quality of life diminished
- Side-benefit: better quality products

Defense Safety Oversight Council (DSOC) Hand-Arm Vibration Project Task Objectives

- Provide **procurement guidelines** for anti-vibration gloves and power hand tools that will reduce personnel exposure to crippling hand-arm vibration exposures while reducing noise exposures and promoting process efficiency (Completed Feb 08)

- Support GSA/DLA procurement of special **anti-vibration gloves** which reduce the vibration transmitted to the fingers and hands during tool use (In process, required information provided)

Defense Safety Oversight Council (DSOC) Hand-Arm Vibration Project Task Objectives

- Support the Federal (GSA/DLA) procurement of more modern designs for **powered hand tools** meeting current performance criteria for reduction of transmitted vibration to the hands when in use (Ongoing)
- Incorporate criteria for **3rd party evaluation** of vibration for gloves and tools into procurement criteria (Completed Feb 08)
- **Communicate** this information **to logistics and safety communities** via DLA, GSA, NIOSH and Service websites (Linked to updated product availability)

DSOC Project Team

- Army
- Navy
- Headquarters U.S. Coast Guard
- Air Force Research Lab
- Defense Logistics Agency, Headquarters
- Government Services Administration
- Contract Support
  - Coordinated by Concurrent Technologies Corporation for OSD Personnel and Readiness (P&R)
  - Don Wasserman (Vibration expert)
  - Robbins Gioia (Logistics Contractor)

Anti-Vibration Gloves (AVG): The Problem

- Many gloves marketed as AVG do not meet the criteria of ISO 10819/ANSI S2.73
  - These include 2 products in the GSA system as National Stock Number (NSN) items
- There are no US regulations for manufacturers to test, certify, and label gloves that meet the ISO/ANSI criteria
- Products currently marketed by GSA as “anti-vibration gloves” do not meet these criteria

AVG: The Approach

- Develop procurement criteria consistent with anti-vibration standard and incorporate into GSA procurement (Completed at NIOSH meeting 2-08)
  - Evaluate compliance with ANSI S2.73 for all gloves intended for use where vibration is a hazard
  - Develop estimates of glove use from current glove National Stock Numbers (completed 5-08)

- Develop a plan to address the need for AVG and ways to procure only ANSI S2.73 compliant gloves

Getting Certified Anti-Vibration Gloves in Supply System

- Two-year effort requiring
  - Intervention of DLA Headquarters, OSD Manpower and Personnel
  - Support of Navy Clothing and Textile Research Facility, Natick, MA
  - Defense Logistics Information Service cataloging
- Process challenges included
  - Poorly described process
  - Differences in motivation among supply contacts
  - Challenges in “new” vendors gaining access to established supply channels
  - Buy-American requirements- overcome by vendors willing to produce American-made products at slightly higher costs
- Certified Anti-Vibration Gloves (photos and sources of), http://safetycenter.navy.mil/acquisition/vibration/downloads/Anti-Vibration_Gloves.pdf

Power Tools: The Problem

- ANSI adopted the European Union Directive in ANSI S2.70 (2006), but it does not contain specific criteria as does the ANSI S2.73 for AVG

- There are no US regulations for manufacturers to test, certify, and label power tools

- Limited prior customer input to GSA/DLA for reduced vibration or noise

Power Tools: The Approach

- Evaluate power hand tools where vibration is a hazard
- Establish procedures for the Qualified Products List (QPL)
- Evaluate possible approaches to facilitate and document labs which can provide testing and evaluation
- Crosslink GSA, DLA, and NIOSH websites
- Make improved products available via GSA schedule both to Federal and Federal contractor buyers

Power Tool Selection Criteria and Request For Vendors Information

- 3rd party report of transmitted vibration
  - Measured in accordance with ANSI 2.70 and NIOSH guidelines under standard, specified conditions
- Air blow off directed away from hands
- Other ergonomic criteria (somewhat dependent on product)
  - Weight – balance – grip dimensions of handle
  - Surface area and force of trigger
  - Recoil or impulse (different than “steady state” vibration)
  - Wrist deviation associated with use
- Consistency with design guidance, noise and vibration to be weighted factors in selection
  - Minimum eligibility criteria likely to be established for the Qualified Products List (QPL) for specific equipment and products
  - Data may be reported in item description and reflected in GSA, DLA and safety/health websites
- Consider warning labels as needed re: noise and vibration

New Tools in Federal Supply System

- GSA is continuing to incorporate low vibration and other ergonomic characteristics into procurement criteria for new and updated power hand tools
- Pneumatic riveting hammer, described as HAMMER, PNEUMATIC, PORTABLE 5130-01-5716908.
  - Its vibration (<2.5 m/s2) is less than half the level created by many legacy tools.
- Pneumatic reciprocating saw, listed as SAW, RECIPROCATING, PNEUMATIC 5130-01-572-5529.
  - Its vibration (<4 m/s2) is less than half the level created by many legacy tools.
- Needle scaler (needle gun), listed as SCALER, PNEUMATIC, PORTABLE 5130-01-317-2453.
  - To date, GSA has been unable to specify a maximum vibration level for this tool.
  - However, one vendor's product, which served as a guide for the item specification, reportedly had vibration levels in the range of 3.5 m/s, also considerably lower than many legacy products.
- **Continued availability will depend on demand!**

Challenges

- Educating industrial hygienists to understand and engage in existing processes for feedback and glove and tool improvement
- Educating safety and industrial hygiene managers to understand the importance of improving workers gloves and tools as opposed to traditional surveys and reports
- Streamlining and clarifying current processes and policies
- Incorporating risk management in glove and tool selection
  - Involves identifying and communicating with responsible technical authorities and program offices
- Communication

Questions?

Dina Koza, NAVAIR